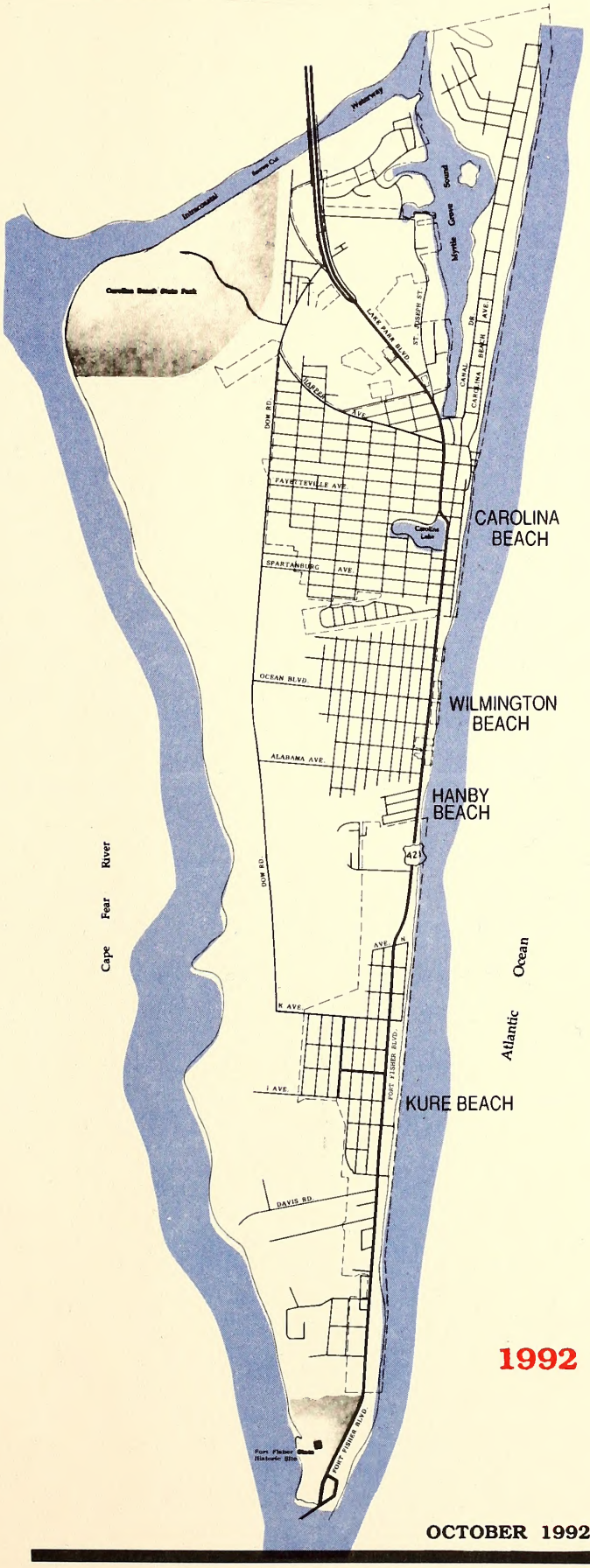
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
STATEWIDE PLANNING BRANCH



CAROLINA BEACH AND KURE BEACH

1992 THOROUGHFARE PLAN

OCTOBER 1992

THOROUGHFARE PLAN

for the

TOWNS

of

CAROLINA BEACH

and

KURE BEACH

Prepared by the:

Statewide Planning Branch
Division of Highways
North Carolina Department of Transportation

In Cooperation with:

The Town of Carolina Beach
The Town of Kure Beach
The Fedeal Highway Administration
U. S. Department of Transportation

October 1, 1992

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ACKNOWLEDGMENTS

The author wishes to thank the staff and local officials for their help in the development of the 1991 Thoroughfare Plan.

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I. INTRODUCTION

Carolina and Kure Beach are located on a barrier island in southern New Hanover County. In addition to the normal recreational activities associated with beach areas, the island is also home to the Fort Fisher Historic Site, Carolina Beach State Park and the North Carolina Aquarium. The island is bounded on the North by the Intracoastal Waterway, on the east by the Atlantic Ocean and on the west by the Cape Fear River.

In October 1990, Carolina Beach requested an update of the Carolina-Kure Beach thoroughfare plan, which was originally adopted in 1973. Because of the closeness of Carolina Beach to Kure Beach, and their common economic patterns, the Department of Transportation felt it was necessary to analyze the needs of the island as a whole.
In the Spring of 1991 staff from Statewide Planning met with the local officials to determine the transportation needs of the area. At Carolina Beach, it was noted that several intersections were experiencing severe congestion problems. The most troublesome of these were Carl Winner Street at US 421 and Carl Winner Street at Canal Drive. In addition, Kure Beach noted that portions of US 421 were inadequate, and asked that we try to relocate the southern portion of it. In addition to these deficiencies, the opening of I-40 from Raleigh to Wilmington, has added to the attractiveness of the area as a vacation getaway, and will certainly bring more growth to the area.

The principles of basic thoroughfare planning, as described in Chapter II, were used to develop this plan. It is based on existing traffic, population, and land use data. Year 2015 average daily traffic (ADT) projections were used to determine capacity deficiencies. Major and minor thoroughfares were located based on field investigations, existing and anticipated land uses, and environmental considerations. The adopted thoroughfare plan is expected to meet the traffic demands of the island for the planning period from 1991-2015.

The North Carolina Department of Transportation and the Towns of Carolina Beach and Kure Beach are jointly responsible for the proposed thoroughfare improvements. Cooperation between the local and state governmental units is of primary concern. The plan has been mutually adopted by all parties and it is the responsibility of the local governmental bodies to implement the plan following the guidelines set forth in Chapter VI. (Carolina Beach adopted the plan on January 14, 1992 and Kure Beach adopted the plan on September 17, 1991. The North Carolina Board of Transportation adopted the plan on April 10, 1992.)

It should be emphasized that the adopted plan is based on anticipated growth of the urban area as currently perceived. Prior to construction of specific projects, a more detailed

study will be required to reconsider development trends and to determine specific locations and design requirements.

GEOGRAPHIC LOCATION MAP FOR CAROLINA BEACH AND KURE BEACH

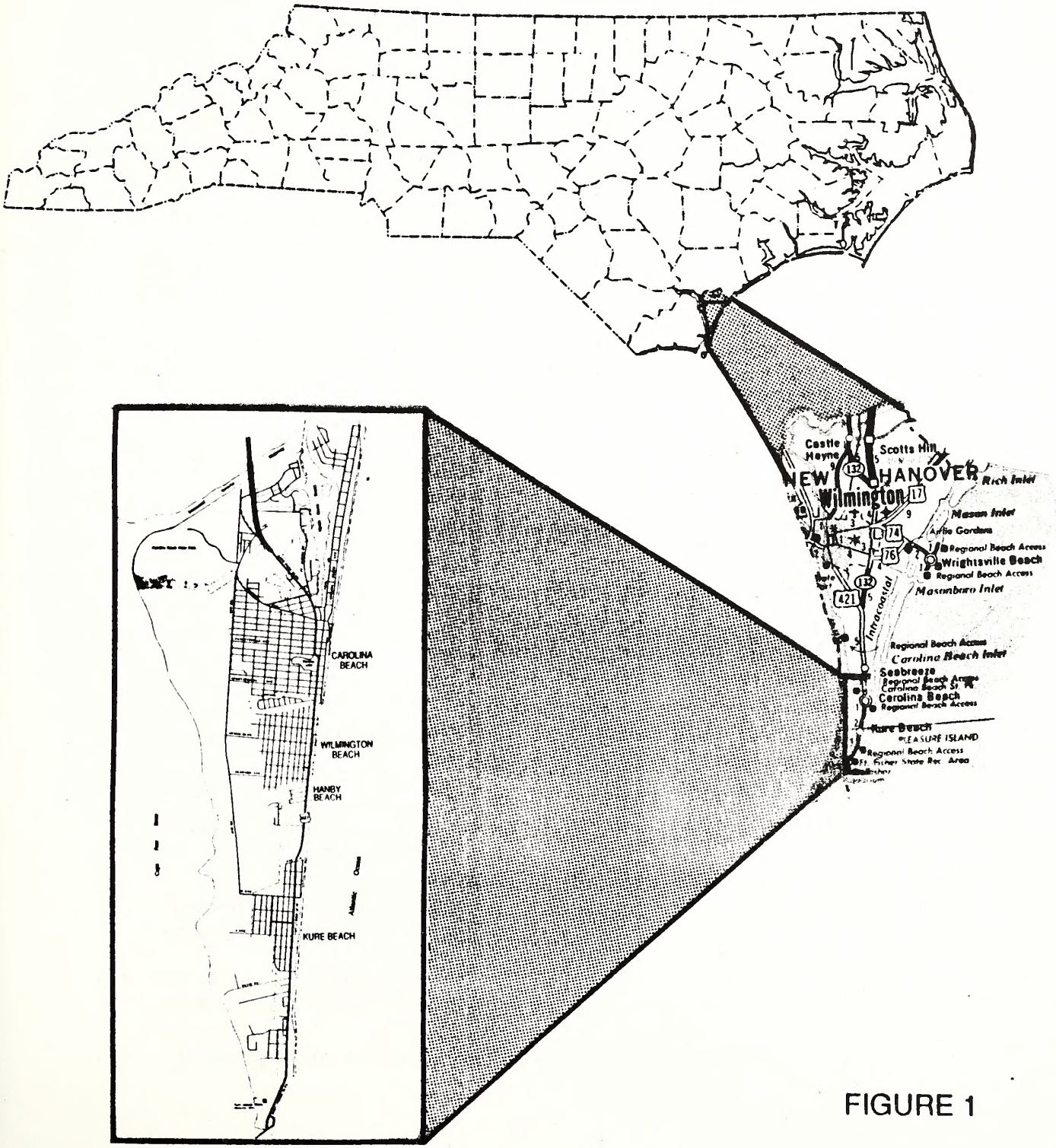


FIGURE 1

II. THOROUGHFARE PLANNING PRINCIPLES

Typically, the urban street system occupies 25 to 30 percent of the total developed land in an urban area. Since the system is permanent and expensive to build and maintain, much care and foresight are needed in its development. Thoroughfare planning is the process public officials use to assure the development of the most appropriate street system that will meet existing and future travel desires within the urban area.

Objectives of Thoroughfare Planning

The primary aim of a thoroughfare plan is to guide the development of the urban street system in a manner consistent with changing traffic demands. Through proper planning for street development, many costly errors and much needless expense can be averted. A thoroughfare plan will enable street improvements to be made as traffic demands increase, and help eliminate unnecessary improvements. By developing the urban street system to keep pace with increasing traffic demands, a maximum utilization of the system can be attained that will require a minimum amount of land for street purposes. In addition to providing for travel needs of the public, the thoroughfare plan should embody those details of good urban planning necessary to present a pleasing and efficient urban community. Just as the location of present and future housing, commercial and industrial enterprises affects major street and highway locations; the location of major streets and highways within the urban area will influence the urban development pattern.

Other objectives of a thoroughfare plan include:

(1) To provide for the orderly development of an adequate major street system as land development occurs;

(2) To reduce travel and transportation costs;

(3) To reduce the cost of major street improvements to the public through the coordination of the street system with private action;

(4) To enable private interests to plan their actions, improvements, and development with full knowledge of public intent;

(5) To minimize disruption and displacement of people and businesses through long range advance planning for major street improvements;

(6) To reduce environmental impacts such as air pollution, resulting from transportation;

(7) To increase travel safety.

Thoroughfare planning objectives are achieved through both: (1) improving the operational efficiency of thoroughfares; and (2) improving the system efficiency through system coordination and layout.

Operational Efficiency

A street's operational efficiency is improved by increasing the capability of the street to carry vehicular traffic and people. In terms of vehicular traffic, a street's capacity is defined as the maximum number of vehicles which can pass a given point on a roadway during a given time period under prevailing roadway and traffic conditions. Capacity is affected by the physical features of the roadway, nature of traffic and weather.

Physical ways to improve vehicular capacity include street widening, intersection improvements, improving vertical and horizontal alignment, and eliminating roadside obstacles. For example, widening of a street from two to four travel lanes more than doubles the capacity of the street by providing additional maneuverability for traffic. Impedances to traffic flow caused by slow moving or turning vehicles, and adverse effects of horizontal and vertical alignments are thus reduced.

Operational ways to improve street capacity include:

(1) Control of access - A roadway with complete access control can often carry three times the traffic handled by a non-controlled access street with identical lane width and number.

(2) Parking removal - Increases capacity by providing additional street width for traffic flow and reducing friction to flow caused by parking and unparking vehicles.

(3) One-way operation - The capacity of a street can sometimes be increased 20-50%, depending upon turning movements and overall street width, by initiating one-way traffic operations. One-way streets can also improve traffic flow by decreasing potential traffic conflicts and simplifying traffic signal coordination.

(4) Reversible lanes - Reversible traffic lanes may be used to increase street capacity in situations where heavy directional flows occur during peak periods.

(5) Signal phasing and coordination - Uncoordinated signals and poor signal phasing restrict traffic flow by creating excessive stop-and-go operation.

Altering travel demand is a third way to improve the efficiency of existing streets. Travel demand can be reduced or

altered in the following ways:

(1) Encourage people to form carpools and vanpools for journeys to work and other trip purposes. This reduces the number of vehicles on the roadway and raises the people carrying capability of the street system.

(2) Encourage the use of transit and the bicycle mode.

(3) Encourage industries, business, and institutions to stagger work hours or establish variable work hours for employees. This will reduce travel demand in peak periods and spread peak travel over a longer time period.

(4) Plan and encourage land use development or redevelopment in a more travel efficient manner.

(5) Plan and encourage the use of sidewalks and bike lanes to more adequately reflect the communities needs.

System Efficiency

Another means for altering travel demand is the development of a more efficient system of streets that will better serve travel desires. A more efficient system can reduce travel distances, time, and cost. Improvements in system efficiency can be achieved through the concept of functional classification of streets and the development of a coordinated major street system.

Functional Classification

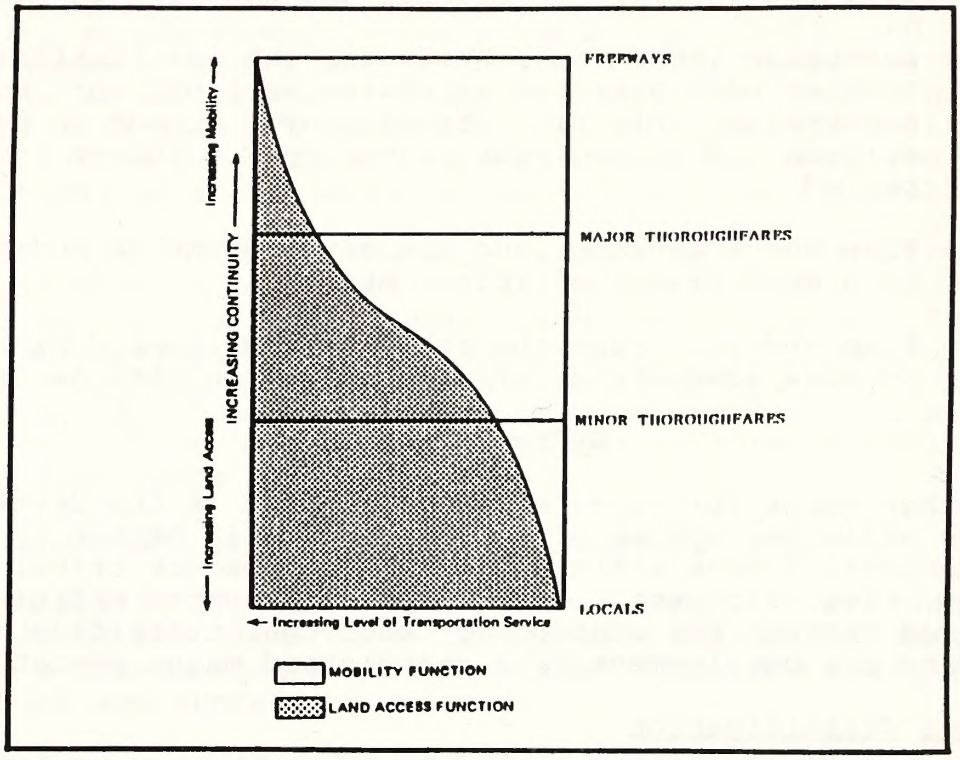
Streets perform two primary functions--traffic service and land service, which when combined, are basically incompatible. The conflict is not serious if both traffic and land service demands are low. However, when traffic volumes are high, conflicts created by uncontrolled and intensely used abutting property lead to intolerable traffic flow friction and congestion. The figure below shows the basic relationship between traffic service and land service. A control of access freeway is an example of a facility that performs only traffic service.

The underlying concept of the thoroughfare plan is that it provides a functional system of streets which permits travel from origins to destinations with directness, ease, and safety. Different streets in the system are designed and called on to perform specific functions, thus minimizing the traffic and land service conflict. Streets are categorized as to function as local access streets, minor thoroughfares, or major thoroughfares (See Figure 2).

Local Access Streets provide access to abutting property. They are not intended to carry heavy volumes of traffic and should be located such that only traffic with origins and destinations on

be located such that only traffic with origins and destinations on the streets would be served. Local streets may be further classified as either residential, commercial, or industrial depending upon the type of land use which they serve.

FIGURE 2 BASIC ROLES OF ROADWAYS



Minor Thoroughfares are more important streets in the city system. They collect traffic from local access streets and carry it to the major thoroughfare system. They may, in some instances, supplement the major thoroughfare system by facilitating minor through traffic movements. A third function which may be performed is that of providing access to abutting property. They should be designed to serve limited areas so that their development as major thoroughfares will be prevented.

Major Thoroughfares are the primary traffic arteries of the city. Their function is to move intracity and intercity traffic. The streets which comprise the major thoroughfare system may also serve abutting property, however, THEIR MAJOR FUNCTION IS TO CARRY TRAFFIC. They should not be bordered by uncontrolled strip development. Such development significantly lowers the ability of the thoroughfare to carry traffic. Each driveway is a danger and an impediment to traffic flow. Major thoroughfares may range from a two-lane street carrying minor traffic volumes to major expressways with four or more travel lanes. Parking normally should not be permitted on major thoroughfares.

Idealized Major Thoroughfare System

A coordinated system of major thoroughfares forms the basic framework of the urban street system. The radial-loop configuration is a major thoroughfare system which is most adaptable to desire lines of travel within an urban area and which permits movement between various areas of the city with maximum directness and ease. This system consists of several functional elements - radial streets, crosstown streets, loops and bypasses (Figure 3). While every city's street system can not conform to the "Idealized Thoroughfare Plan" because of local idiosyncrasies, the concepts are adequate to apply to all areas.

Radial streets provide for traffic movement between points located in the outskirts of the city and the central area. This is a major traffic movement in most cities, and the economic strength of the central business district depends upon the adequacy of this type of thoroughfare.

If all radial streets crossed in the central area, an intolerable congestion problem would result. To avoid this problem, it is very important to have a system of **crosstown streets** which form a loop around the central business district. This system allows traffic moving from origins on one side of the central area to destinations on the other to follow the area's border and allows central area traffic to circle and then enter the area near a given destination. The effect of a good crosstown system is to free the central area of crosstown traffic, thus permitting the central area to function more adequately in its role as a pedestrian shopping area.

Loop system streets move traffic between suburban areas of the city. Although a loop may completely encircle the city, a typical trip may be from an origin near a radial thoroughfare to a destination near another radial thoroughfare. Loop streets do not necessarily carry heavy volumes of traffic, but they function to help relieve central areas. There may be one or more loops, depending on the size of the urban area, and they are generally spaced one-half mile to one mile apart, depending on the intensity of land use.

A **bypass** is designed to carry traffic through, or around the urban area, thus providing relief to the city street system by removing from it traffic which has no desire to be in the city. Bypasses are usually designed to through highway standards, with control of access. Occasionally, a bypass with low traffic volume can be designed to function as a portion of an urban loop. The general effect of bypasses is to expedite the movement of through traffic and to improve traffic conditions within the city. By freeing the local streets for use by shopping and home-to-work traffic, bypasses tend to increase the economic vitality of the local area.

IDEALIZED THOROUGHFARE PLAN

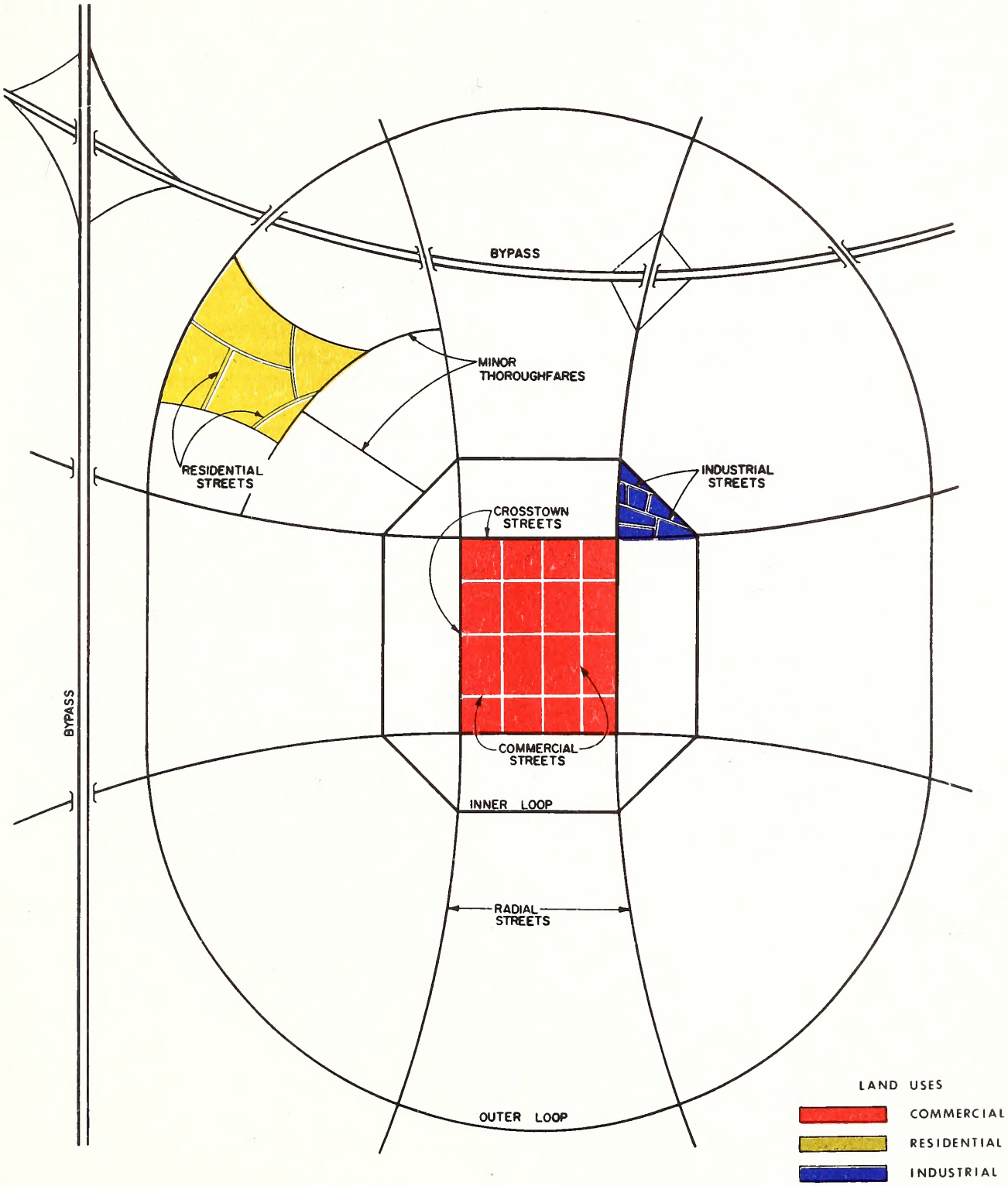


FIGURE 3

Application of Thoroughfare Planning Principles

The concepts presented in the discussion of operational efficiency, system efficiency, functional classification, and idealized major thoroughfare system are the conceptual tools available to the transportation planner in developing a thoroughfare plan. In actual practice, thoroughfare planning is done for established urban areas and is constrained by existing land use and street patterns, existing public attitudes and goals, and current expectations of future land use. Compromises must be made because of these and the many other factors that affect major street locations.

Throughout the thoroughfare planning process it is necessary from a practical viewpoint that certain basic principles be followed as closely as possible. These principles are as follows:

1. The plan should be derived from a thorough knowledge of today's travel - its component parts, as well as the factors that contribute to it, limit it, and modify it.

2. Traffic demands must be sufficient to warrant the designation and development of each major street. The thoroughfare plan should be designed to accommodate a large portion of all major traffic movements on a relatively few streets.

3. The plan should conform to, and provide for the land development plan of the area.

4. Certain considerations must be given to urban development beyond the current planning period. In outlying or sparsely developed areas which have development potential, it is necessary to designate thoroughfares on a long-range planning basis to protect rights of way for future thoroughfare development.

5. While being consistent with the above principles and realistic in terms of travel trends, the plan must be economically feasible.

III. SOCIOECONOMIC CONDITIONS

The amount and type of housing and employment in an area will determine to a large extent, the type of travel that will be using the local roadways. By making reasonable assumptions concerning the future population and land use, the magnitude of the future transportation system can be determined fairly accurately. For this study, the population and land use figures were compiled from the most recent land use updates for the two areas as well as from the 1990 census.

Population Trends

The economy of the island is mostly tourism related. On any given day, the population may consist of three distinct groups: permanent residents, short term residents and daily visitors. Table 1 shows the relevant population figures for the area. Current figures put the seasonal population levels for the island at 30,000-35,000 people per day during the peak season.

TABLE 1 PERMANENT POPULATION AND PROJECTIONS

	1960	1970	1980	1990	2000[1]	2010[1]	2015[1]
Carolina Beach	1192	1663	2000	3993	5150	7265	8629
Kure Beach	293	394	611	619	1450	2000	2433
New Hanover County	71742	82996	103471	120284	135577	147812	164485

[1]Population projections from the Carolina Beach Land Use Plan Update, the Kure Beach Land Use Plan Update, and from the NC Office of State Budget and Management

Land Use

The predominant type of developed land use on the island is residential. The residential sector is made up of single and multi-family homes. Condominiums and motels are mostly located along the beach front. Most alarming as far as the transportation system is concerned is the increased density to which development is occurring. This development is mostly oceanfront, which unfortunately for US 421, is resulting in a staggering increase in the number of vehicles using this road.

Recreational uses are the main attraction to the area. In addition to the seven miles of beach, there are other recreational amenities. Near the intersection of Dow Road and US 421 lies Carolina Beach State Park. South of Kure Beach lies the Fort Fisher Historic Site and the North Carolina Aquarium. Interspersed among the oceanfront housing are regional beach access points.

Commercial areas are concentrated mostly along US 421. Carolina Beach's Central Business District, which contains the boardwalk, is located between Lake Park Boulevard, the Atlantic Ocean and generally south of Harper Avenue. Kure Beach has a concentration of commercial development surrounding the pier at the intersection of US 421 and K Avenue.

A large portion of the undeveloped land on the island, generally west of Dow Road, is a part of the Sunny Point Military Ocean Terminal Buffer Zone and no residential construction is allowed in this area. At this time, there are no plans for this area to be developed. However, if this is ever released for private development, there would be significant transportation impacts to the area.

Future growth is constrained only by the ability of the Towns to provide adequate utilities and by the amount of developable land available. The thoroughfare plan assumes that future growth will not be unduly restrained by the lack of utilities. In addition, there is sufficient land available to accommodate the future growth. Although the current majority of building is that of single family construction, the past trend has been that of replacing lower density housing with higher density multi-family housing. While this housing provides tremendous economic benefits to Carolina Beach, if this trend were to continue into the future, US 421 would be severely congested.

The completion of I-40 from Raleigh to Wilmington is also expected to have an impact on the island. Daily visitors are expected to increase, thus resulting in parking problems and an increase in daily traffic. In addition, because the beaches are more accessible to a larger portion of the State, I-40 will likely contribute to an above average rate of growth in the secondary housing market for the planning horizon.

IV. DEFICIENCY ANALYSIS

The deficiency analysis is an important part of the thoroughfare plan study. Recommended street and highway improvements are based on deficiencies in the street system that exist today as well as problems that may occur as a result of future travel.

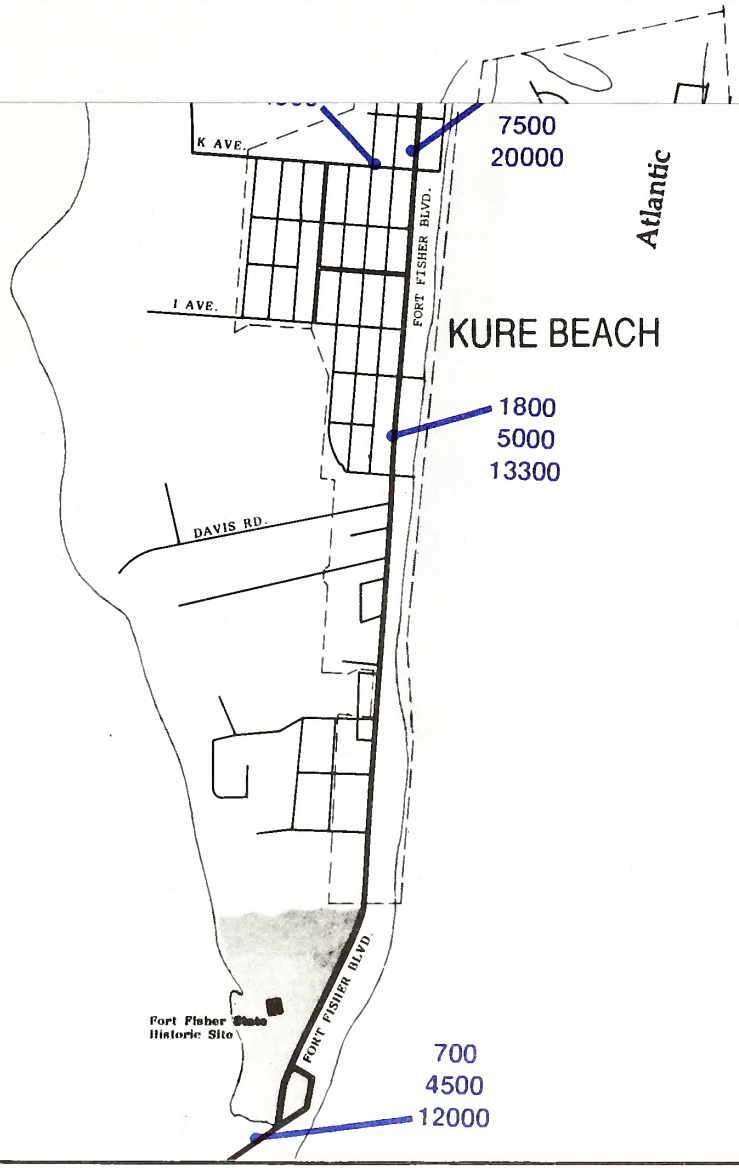
Travel

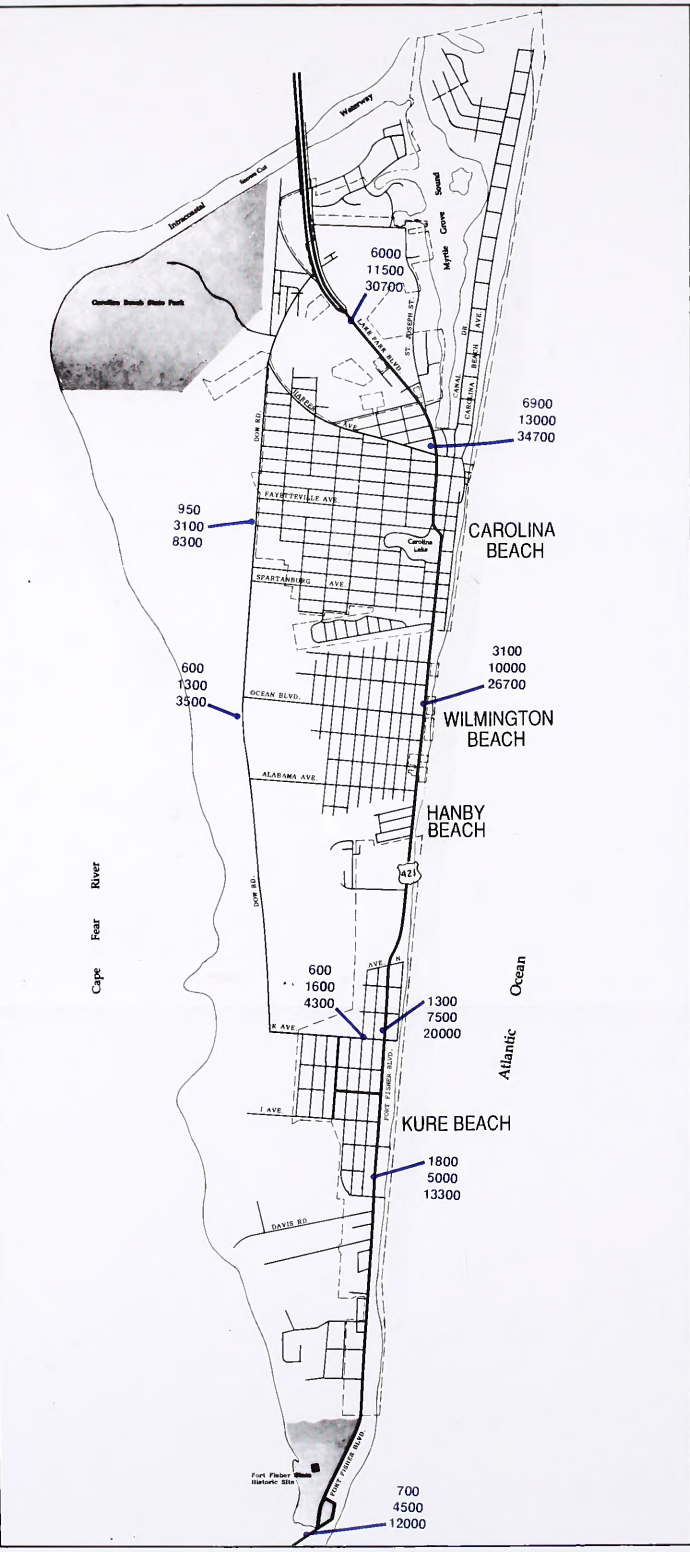
The island is separated from the mainland by the intracoastal waterway. A high level bridge to the north provides access to the Wilmington Urban Area. To the south, below Fort Fisher, ferry service is provided to the Southport area of Brunswick County. The main travel flows on the island are north-south with the majority of travel utilizing US 421. Travel to the island is mostly by private automobile, with some buses chartered by individual groups. Long intra-island trips are made by automobile. Pedestrian and bicycle travel are also present, but are somewhat dangerous. US 421 is heavily used and was not built to accommodate pedestrians or bicyclists.

Two types of travel utilize US 421: external-internal trips and internal trips. The external-internal trips consist mostly of direct trips from outside the area to motels and cottages or day trips to beach parking areas, restaurants and the Fort Fisher area. The second major travel component is the internal trips. These are those short trips made once people arrive on the island. The mode of travel for these trips include: private automobile, walking or bicycling.

Dow Road offers an unimpeded route between Lake Park Boulevard and the southern portions of the island. Even with the current congestion on US 421, Dow Road, which is a parallel facility, is not very well utilized. Though some people would stay on US 421 because of its scenery or services available, Dow Road's non-use is a result of two factors: some people are not aware that it exists and those that are aware of it, do not realize the ease of which east-west movements can be made. Figure 4 shows historical and projected traffic flows for the area. Most alarming of these traffic counts are the significant increases in travel on US 421 south of Carolina Beach. In most cases, travel has tripled from 1980 to 1990.

The inadequate capacity of US 421 severely limits the north-south movement of travel on the island. Its character is such that its main purpose is access to local services and recreational needs. It is a poor choice for those travellers whose destination is the south Carolina Beach Area, Kure Beach, the Ferry and the recreational areas south of Kure Beach.


K AVE.
I AVE.
DAVIS RD.
FORT FISHER BLVD.
FORT FISHER BLVD.
Atlantic
KURE BEACH
Fort Fisher State Historic Site
7500
20000
1800
5000
13300
700
4500
12000
0
1000
2000
3000
SCALE IN FEET



CAROLINA BEACH & KURE BEACH

NORTH CAROLINA

PREPARED BY THE

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

DIVISION OF HIGHWAYS-PLANNING AND ENVIRONMENTAL BRANCH

IN COOPERATION WITH

U.S. DEPARTMENT OF TRANSPORTATION

FEDERAL HIGHWAY ADMINISTRATION

MAY 1991

FIGURE 4

AVERAGE DAILY TRAFFIC

0000 1980
0000 1990
0000 2015 (w/o TP)

Seasonal variations may increase these volumes by 25% to 50%

0 1000 2000 3000
SCALE IN FEET

In addition to N-S movements on US 421, the increasing development on the northern extension of the island is creating problems. Currently, two routes serve this area; Canal Drive and Carolina Beach Avenue North. Carolina Beach Avenue North is one way north bound with parking on one side and is not very well marked. In addition, pedestrians are prevalent along this route. Canal Drive is two lanes. In addition to these roads' inability to move traffic during the peak times, there are serious questions about the accessibility of emergency vehicles to this area. Carl Winner Avenue and Harper Avenue severely limit the amount traffic that these streets can handle. Other system and accessibility problems occur in accessing St. Joseph's Street and the adjacent area.

System Deficiencies

As explained in Chapter II system deficiencies must also be analyzed to enhance the transportation system of an area. This section is mainly concerned with transportation problems that affect a person's overall travel in an area, or that severely limit the accessibility of an area.

A very real concern for the area is the possibility that a portion of US 421 could become unusable, or lost because of beach erosion. A recent study conducted by the Center for Transportation Engineering Studies[1] determined that there are 22 sections of coastal highways that will become vulnerable to overwash or damage between the period from 1990 to 2010. In fact, 18 of these sections are already threatened. Of upmost concern is the 3.6 mile section identified in the Carolina-Kure Beach Area which has been vulnerable since the early 1950's and in some cases the road comes within 100 feet of the beach. This section stretches from the North Carolina Aquarium to Texas Avenue in Carolina Beach. Though this entire section is vulnerable and subject to be threatened, the most critical section occurs between the Aquarium and Assembly Avenue. Carolina Beach and Kure Beach both support periodic renourishment of the beach to save not only the road, but also the highly developed beachfront. At any time, a major storm could occur that would totally wipe out a portion of the road. Important historical and recreational facilities are located south of the vulnerable section and it is imperative that US 421 remain in service.

Intersection Analysis

As part of the Thoroughfare Planning process an attempt

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[1] Stone, J.R., M.F. Overton, J.S. Fisher, "Options for North Carolina Coastal Highways vulnerable to long term Erosion", Center for Transportation Engineering Studies, NCSU, August 1991.

was made to identify problem intersections. Through this process the following intersections were identified as having problems:

a. **Canal Drive at Carl Winner Street** - Left turns from Carl Winner Street back up because Canal Drive only has one southbound lane. This contains a mix of through and right turning traffic. The left turns from Carl Winner Drive are very heavy because of the intense development on the northern extension. Also, the marina creates a problem because of onlooker delay. In addition, during peak times this intersection is highly congested because it provides the main access to the rapidly growing northern extension of the island.

b. **Lake Park Boulevard at Carl Winner Street** - The problems at this intersection are a direct result of the inability of the previous intersection to properly process traffic. Vehicles back up at the previous intersection and prevent any additional traffic from entering Carl Winner. In addition, the lack of a south bound left turn lane onto Carl Winner Avenue greatly restricts traffic flow southbound on US 421. Solutions to the problems must not only address this individual intersection, but the access to the northern extension must be looked at on a system basis.

c. **Lake Park Boulevard at St. Joseph Street** - St. Joseph Street intersects Lake Park Boulevard at a very skewed angle. The inability of vehicles to access Lake Park Boulevard at St. Joseph's Street is creating the undesirable situation of cars cutting through Federal Point Shopping Center.

d. **Woody Hewett Street at Lake Park Boulevard** - The problems at this intersection are two fold. First Woody Hewett Street intersects Lake Park Boulevard at a skewed angle. Secondly, this intersection is at a very critical section of Lake Park Boulevard. There are only two lanes of travel and the intersection is at the start of a very sharp curve.

e. **Dow Road at Lake Park Boulevard** - This Intersection is a maze of traffic islands. It was created when there was not much of a desire to go down Dow Road. The construction of the post office has brought an increase in traffic to this intersection. In addition, the increasing importance of Dow Road to island transportation system will further necessitate improvements to this intersection.

f. **Dow Road at K Avenue** - Dow Road intersects K Avenue at a ninety degree angle. Because of the high speed on Dow Road there have been numerous instances of cars running

off the road because they could not make the turn.

g. **US 421 at Side Streets** - The intersection of various non-signalized streets with US 421 create problems related to left and right turns into and out of these streets, especially during peak periods of travel.

Accident Analysis

An accident analysis was done for the five year period from January 1, 1987 to December 31, 1991 for the entire planning area. Table 2 shows the intersections with the most accidents. Notably, the majority of the high accident intersection are located near Carolina Beach's central business area and are on US 421. They result from the increased congestion in this area and the lack of a left turn lane off of US 421.

In addition to individual intersections, an accident strip analysis was also done. More specifically, individual sections of roadway were analyzed to determine if their accident rates were higher than state averages. Of the sections considered, US 421 between Atlanta Avenue and Federal Point Shopping Center is the most problematic. For the five year period, this 1.03 mile section had 66 accidents with an estimated property loss of $153,100. There were also 35 injuries that occurred during these accidents. This total included 16 rear end collisions, 19 turning collisions and 14 angle collisions. Sixty percent of these accidents occurred during the peak tourist season from June to August. This is especially pertinent, because it gives an indication the problems that may occur as the traffic continues to increase.

Table 2 **Intersection Accidents**

Intersection	# Acc	Inj Acc
US 421 @ Winner Ave	12	5
US 421 @ Carl Winner Ave	11	3
US 421 @ K Ave	10	3
US 421 @ Cape Fear Blvd	8	2
US 421 @ Harper Ave	8	1
US 421 @ Dow Rd	7	1
US 421 @ Lumberton	5	1
Canal @ Carl Winner Ave	3	4

*Period from 1/1/87 - 12/31/92

Causal factors for the different types of accidents may include the following. Rear end accidents along US 421 are primarily due to the accordion effect produced in high

density vehicle streams when a vehicle brakes to avoid a collision with another vehicle in its path. These conflicting vehicles are executing either slowing, turning, or crossing movements. This is compounded by the excessive number of stops and delays associated with high pedestrian movements and a high number of driveways, in addition the lack of a turn lane is another cause. Left turn and right angle accidents along US 421 are primarily due to inadequate numbers of acceptable gaps in the opposing-vehicle stream.

Capacity Analysis

A good indication of the adequacy of the existing major street system is a comparison of the traffic volumes with the ability of the streets to move traffic freely at a desirable speed. The ability of a street to move traffic freely, safely, and efficiently with a minimum of delay is controlled principally by the spacing of major intersections, the width of the pavement, and the traffic control devices utilized. Thus, the ability of a street to move traffic can be increased by restricting parking and turning movements, using proper sign and signal devices, and by the application of other traffic engineering techniques.

Capacity is defined as the maximum number of vehicles which have a reasonable expectation of passing over a given section of a roadway in one direction, or in both directions, during a given time period under prevailing roadway and traffic control conditions.[1] The relationship of traffic volumes to the capacity of the roadway will determine the level of service being provided. Six levels of service have been selected to identify the conditions existing under various speed and volume conditions on a highway or street.

The six levels of service are illustrated in Figure 5, and they are defined on the following pages. The definitions are general and conceptual in nature, and they apply primarily to uninterrupted flow. Levels of service for interrupted flow facilities vary widely in terms of both the user's perception of service quality and the operational variables used to describe them. Each chapter of the 1985 Highway Capacity Manual contains more detailed descriptions of the levels of service as defined for each facility type.

1. **Level-of-service A** describes primarily free flow-operations at average travel speeds usually about 90 percent of the free flow speed for the arterial class. Vehicles are completely unimpeded in their ability to maneuver within the traffic stream. Stopped delay at signalized intersections is minimal.

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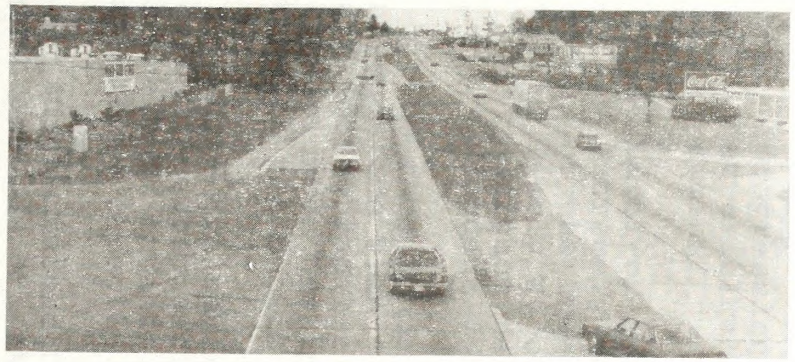
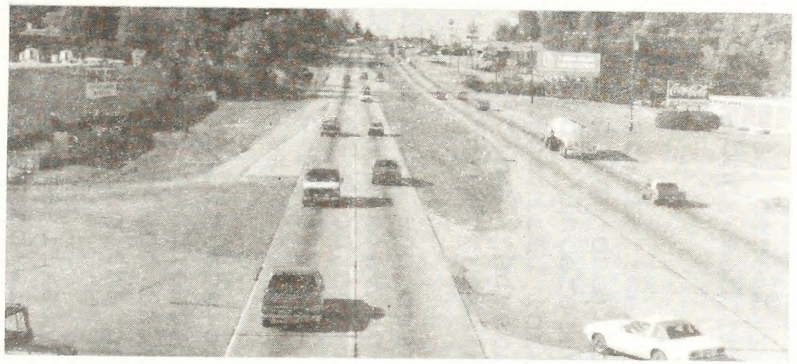
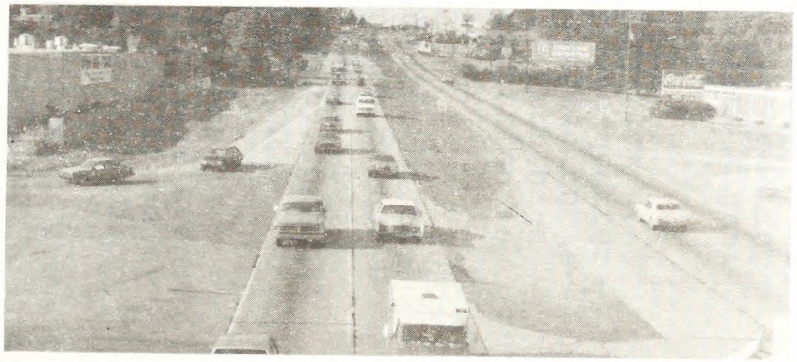
1. Highway Capacity Manual, Highway Research Board Special Report 209, 1985, Page 1-3.



LEVEL OF SERVICE - A



LEVEL OF SERVICE - B



LEVEL OF SERVICE - C

LEVEL OF SERVICE - D

LEVEL OF SERVICE - E

LEVEL OF SERVICE - F

LEVELS OF SERVICE

FIGURE 5

2. **Level-of-service B** represents reasonable unimpeded operations at average travel speeds usually about 70 percent of the free flow speed for the arterial class. The ability to maneuver within the traffic stream is only slightly restricted and stopped delays are not bothersome. Drivers are not generally subjected to appreciable tension.

3. **Level-of-service C** represents stable operations. However, ability to maneuver and change lanes in midblock locations may be more restricted than in LOS B, and longer queues and/or adverse signal coordinations may contribute to lower average travel speeds of about 50 percent of the average free flow speed for the arterial class. Motorists will experience an appreciable tension while driving.

4. **Level-of-service D** borders on a range on which small increases in flow may cause substantial increases in approach delay and, hence, decreases in arterial speed. They may be due to adverse signal progression, inappropriate signal timing, high volumes, or some combination of these. Average travel speeds are about 40 percent of free flow speed.

5. **Level-of-service E** is characterized by significant approach delays and average travel speeds of one-third the free flow speed or lower. Such operations are caused by some combination of adverse progression, high signal density, extensive queuing at critical intersections, and inappropriate signal timing.

6. **Level-of-service F** characterizes arterial flow at extremely low speeds below one-third to one-quarter of the free flow speed. Intersection congestion is likely at critical signalized locations, with high approach delays resulting. Adverse progression is frequently a contributor to this condition.

The recommended improvements and overall design of the Thoroughfare Plan were based on achieving a minimum of LOS D on existing facilities, and LOS C on new facilities. LOS D is considered the **"practical capacity"** of a facility, or that at which the public begins to express dissatisfaction.

There are several locations in the area that are currently experiencing capacity problems. Carl Winner Avenue is the most notable. Canal Drive and Lake Park Boulevard experience capacity problems during the peak summer months.

In the future these areas are likely to get worse. The worst section of Lake Park Boulevard will be the two lane

section near the lake. The road's severe curves and limited widening potential makes this section extremely critical. Unless diverted, all travel to southern Carolina Beach and Kure Beach must pass through this point, and may experience extreme delays in the future. Though currently only congested during the summer, this section will likely have a poor LOS year round in the future. The remaining portions of US 421 are not going to escape unscathed. Though widening to three lanes will help the LOS somewhat, it will not likely be able to adequately handle the future volumes expected. An important point to remember is that the peak tourist season may only last five to six months.

Vacationers may have a tendency to become frustrated with overcrowded streets and lack of available parking, an element they wish to avoid while vacationing. This may cause an immediate impact upon the local trades and services, and may result in an overall impact to the tourism trade by individuals seeking out areas for vacationing less crowded and more easily accessible. While it may not be practical to design a transportation system that accommodates the peak hour of travel on the peak summer day, it is imperative that people be given alternate means of reaching their destinations if at all possible.

V. 1992 THOROUGHFARE PLAN

Just as Carolina Beach and Kure Beach are two separate Towns, so are their transportation needs. The common thread that links them is their location. While their needs might be different, they are interrelated, and their needs must be considered as a unit. In late 1990 staff met with officials from both Kure Beach and Carolina Beach. Each decided to develop their thoroughfare plan in a different manner.

Development of Recommendations

Kure Beach's planning jurisdiction is generally that area south of Alabama Avenue to Fort Fisher. Kure Beach's portion of the plan was developed in conjunction with the Kure Beach Town Board. Staff met with the Kure Beach Town Board on March 19, 1991 to discuss the thoroughfare planning process and any transportation problems that the Town might have. On May 7, 1991 a public workshop was held to receive input from the citizens of the entire island. Though this workshop was lightly attended, we did receive several good suggestions. On July 16, 1991 staff presented the recommended plan to the Council. The public hearing on the plan was held on September 17, 1991.

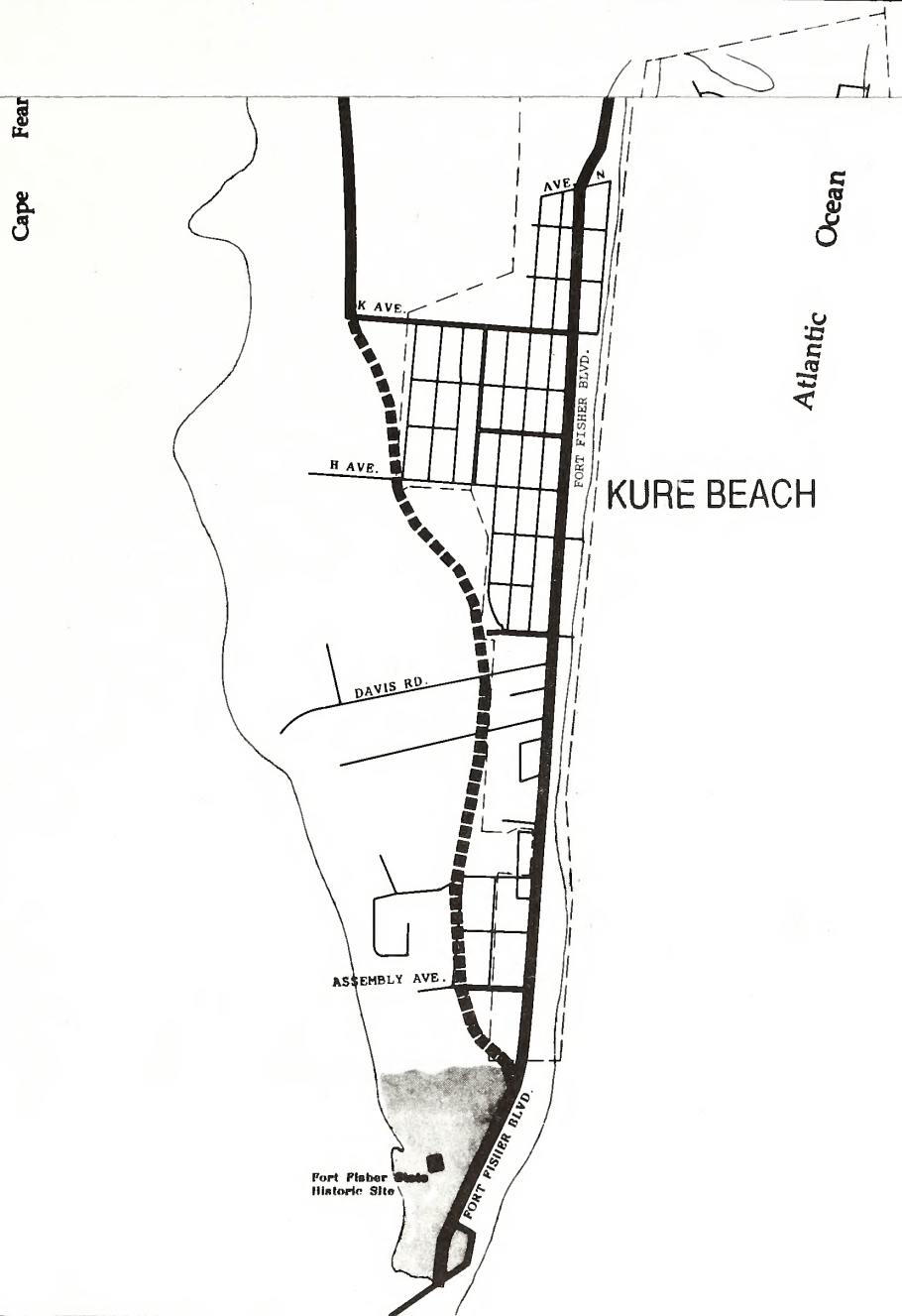
Carolina Beach has planning control over the area north of Alabama Avenue to Snow's Cut. Carolina Beach's portion of the plan was developed in conjunction with their Planning Board. Through a series of meetings they developed a recommended plan that addressed the needs of the area. The recommendations were presented to the Town Council at a work session on September 10, 1991.

The recommended plan (see figure 6) was adopted by the Town of Kure Beach on September 17, 1991 and by the Town of Carolina Beach on January 14, 1992. The North Carolina Board of Transportation adopted the plan on April 3, 1992.

Elements of the Adopted Plan

<u>Carl Winner Avenue and Canal Drive Intersection</u>

The access to the northern extension is one of the major concerns for the area. The intersection of Carl Winner Avenue and Canal Drive severely constrains the amount of travel that may access Canal Drive or Carolina Beach Avenue North. Placing a signal at this intersection is not the absolute solution to this problem, and would most likely contribute more problems because it could not process as many vehicles as the existing configuration. Further investigation uncovered several deficiencies. The main one being that the existing street system just does not have the capacity to handle the volume of traffic to this part of the



ADOPTED BY:
TOWN OF CAROLINA BEACH JANUARY 14, 1992

TOWN OF KURE BEACH SEPTEMBER 17, 1991

RECOMMENDED FOR APPROVAL BY:
NC DEPARTMENT OF TRANSPORTATION
STATEWIDE PLANNING BRANCH MARCH 9, 1992

ADOPTED BY:
NC DEPARTMENT OF TRANSPORTATION APRIL 3, 1992

PUBLIC HEARING: SEPTEMBER 17, 1991

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SCALE IN FEET

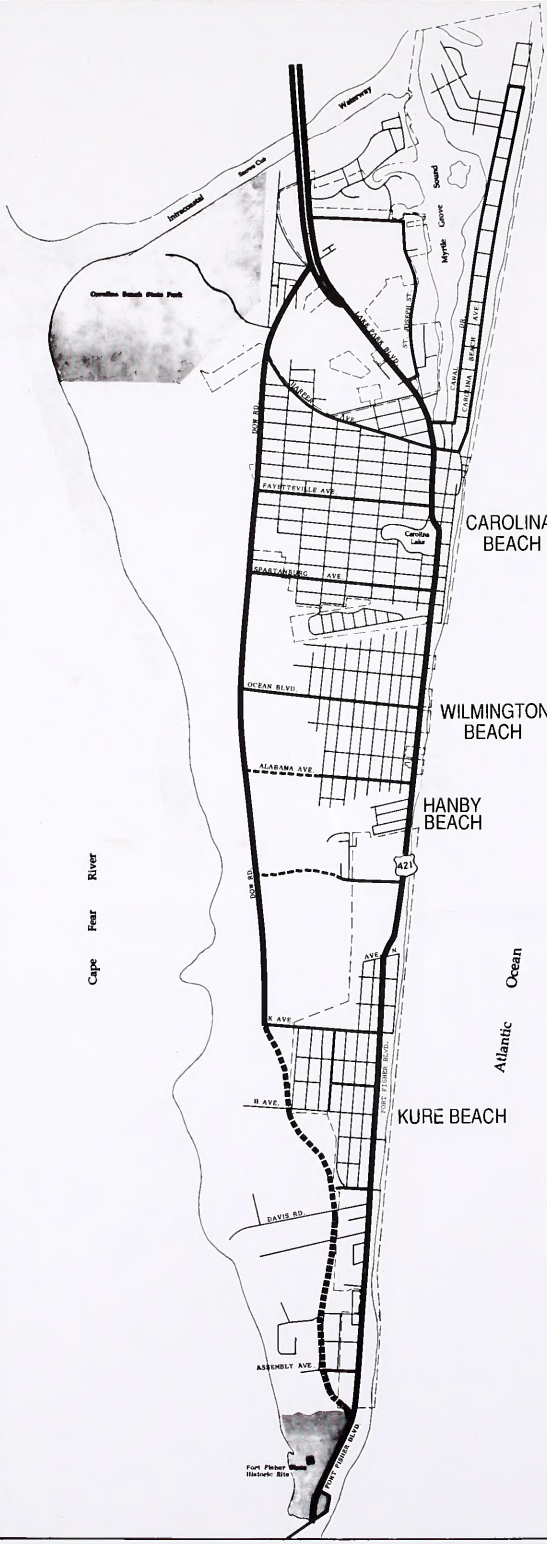

FIGURE 6

THOROUGHFARE PLAN

CAROLINA BEACH & KURE BEACH

NORTH CAROLINA

PREPARED BY THE

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

DIVISION OF HIGHWAYS-PLANNING AND ENVIRONMENTAL BRANCH

IN COOPERATION WITH

U.S. DEPARTMENT OF TRANSPORTATION

FEDERAL HIGHWAY ADMINISTRATION

JUNE 10, 1991

N

LEGEND

	EXISTING	PROPOSED
MAJOR THOROUGHFARE	▬▬▬	▬ ▬ ▬ ▬
MINOR THOROUGHFARE	———	- - - -

ADOPTED BY:
TOWN OF CAROLINA BEACH JANUARY 14, 1992
TOWN OF KURE BEACH SEPTEMBER 17, 1991

RECOMMENDED FOR APPROVAL BY:
NC DEPARTMENT OF TRANSPORTATION
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SCALE IN FEET

island. Statewide Planning, in conjunction with the Municipal Traffic Assistance Program (NCDOT, Traffic Engineering) developed a recommended design to improve the access to the northern extension (see Figure 7). The design involves making Harper Avenue a one way pair system with Carl Winner Avenue. This will greatly improve the access to the boardwalk area. Secondary benefits include increased capacity of the street network because of one way operation and better traffic flow onto and off of US 421. It will also benefit the Marina by making it more easily accessible to those who wish to go there. This improvement is expected to be an immediate, low cost solution that will greatly improve the traffic flows into the area. The lanes shaded in the figure represent future lanes that are recommended once the funds become available. Close coordination between the Town and NCDOT will be required in order to ensure that the final configuration is compatible with the overall needs of the system as a whole.

Proposed Signal Plan

Adjacent to US 421 are numerous side streets and multi-family rental properties. Signals currently exist at the intersections of Federal Point Shopping Center, Carl Winner Avenue, Harper Avenue, Cape Fear Boulevard and K Avenue. As part of the signal plan we recommend that priority for signals be at the following intersections where minor thoroughfares cross US 421: Winner Avenue, Fayetteville Avenue, Spartanburg Avenue, Ocean Boulevard, Alabama Avenue and Kure Beach Way. Projected volumes, and current peak summer volumes on US 421 are such that very few gaps exist for people to access US 421 from the side streets. This results in extremely long delays for these people. If signals are allowed to be installed in a haphazard manner, it will result in unsatisfactory stop and go traffic. Properly spaced signals also allow for a coordinated signal system that will allow vehicles to progress through a system of signals at an adequate speed.

Road Improvements

The following is a list of roads that are recommended to serve as major and minor thoroughfares as discussed in Chapter II. A brief discussion of the road's deficiency and function is included to support its classification as a thoroughfare. For a more complete description of a roads deficiencies see chapter V. More detail on physical and operational characteristics is given in Appendix A, Table A1.

Major Thoroughfares

US 421 - Referred to as Lake Park Boulevard in Carolina Beach and Fort Fisher Boulevard in Kure Beach. It is currently a mixture of cross sections and is the major north-south route.

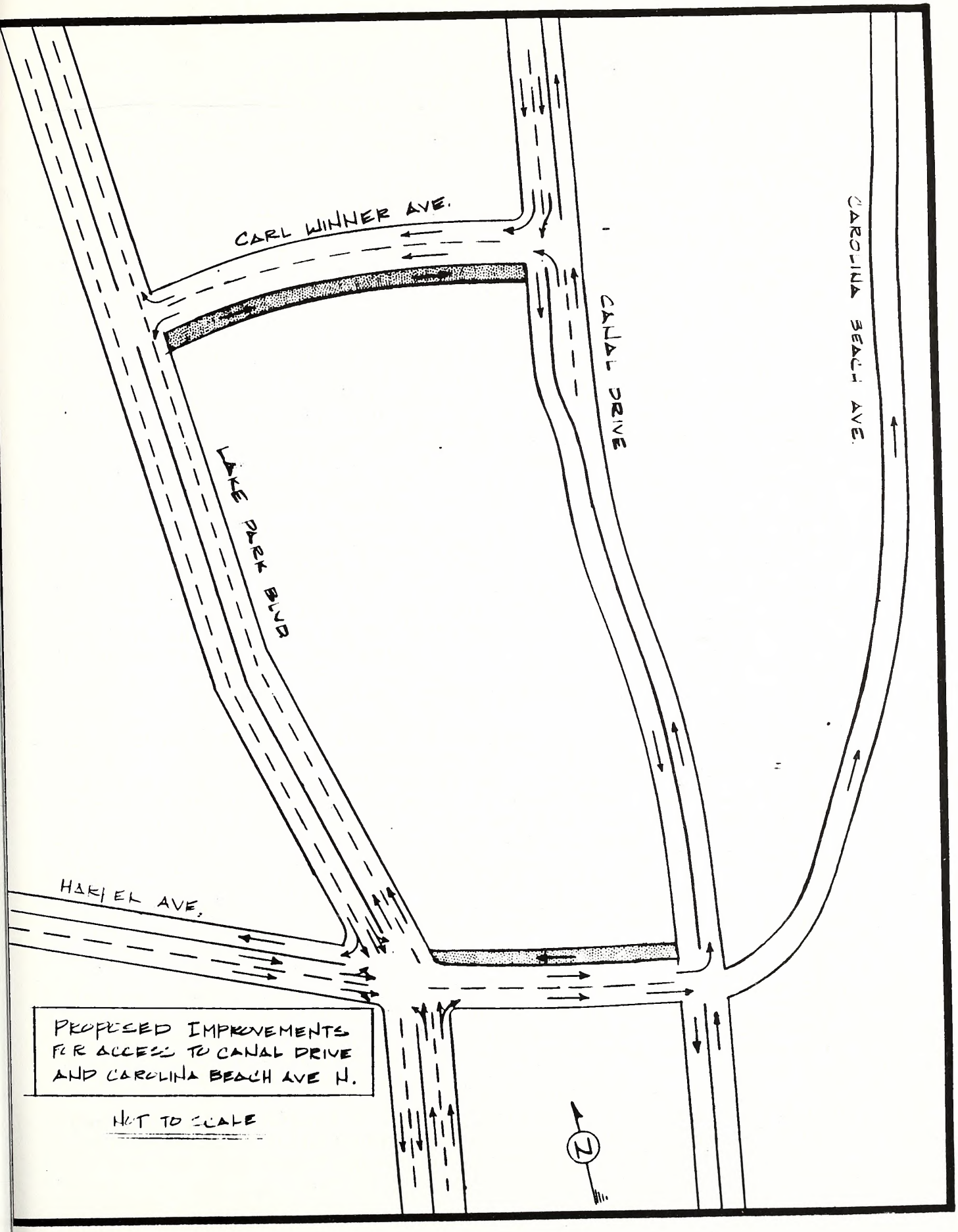

CARL WINNER AVE.
CANAL DRIVE
CAROLINA BEACH AVE.
LAKE PARK BLVD
HARIEL AVE.
PROPOSED IMPROVEMENTS FOR ACCESS TO CANAL DRIVE AND CAROLINA BEACH AVE N.
NOT TO SCALE
N

FIGURE 7

Except on those portions that are existing 4 lanes, we are recommending a final cross section of 3 lanes to help reduce the left turning and angle conflicts that are now occurring. The segment around Carolina Lake will be the most critical in the future. Its severe curve and the unlikelihood of it being widened, is a major constraint to the proper flow of travel through Carolina Beach. It is expected that as travel continues to increase and the average speed decreases, Dow Road will become a much more attractive route. US 421 will be reduced to carrying short trips between homes and commercial and recreational areas. It is expected that Dow Road will become the road of choice for longer trips and external-internal trips.

Dow Road - This road is presently under utilized. It is recommended that the section from Lake Park Boulevard to K Avenue be improved to a four lane urban boulevard cross section with intermittent breaks in the median at the minor thoroughfare locations for left turns. For the section from K Avenue south to US 421 we are recommending a 2 lane urban boulevard cross section with breaks in the median for left turns at key intersections. For those areas along Dow Road that are available for development, it is imperative that all possible measures be taken to protect the future right-of-way line. The entire road is critical to the proper flow of travel in the area. With the exigency of US 421 near Fort Fisher it is imperative the local officials push to have this project included in the State's Transportation Improvement Program as soon as possible.

Minor Thoroughfare

Carl Winner Avenue - This road serves as the main access point to the northern extension of the island. It currently carries two way lanes with parking. Our recommendation is for it to be a one way street with two lanes westbound. It is expected to function as a one way pair system with Harper Avenue. While an east bound lane may be needed for land access, it could represent significant project costs, and unlike implementing the one way pair system,may require several years to be implemented. The one way pair is expected to bring immediate relief to the congestion problems associated with accessing the northern extension.

Harper Avenue - This road currently serves as the main access point to Carolina Beach Avenue and to a lesser extent, Canal Drive. We are recommending that this road be converted to two one way lanes eastbound and will function as a one way pair with Carl Winner Avenue.

Carolina Beach Avenue - This is currently one lane northbound with parking. It has heavy pedestrian traffic. At this time we are not recommending any widening for this road.

Canal Drive - This currently is two lanes, one each direction. We are recommending a future cross section of 3 lanes (2 southbound and 1 northbound). This widening should be accommodated within the existing ROW.

St. Joseph's Street - The only major improvement to this road is at its intersection with US 421. It is recommended that all traffic entering or leaving St. Joseph's Street be routed onto Winner Avenue. A future signal is expected to be located at this location. St. Joseph's Street from US 421 to Winner Avenue will be converted to one way north bound with access only from the north bound US 421 direction.

Alabama Avenue, Kure Beach Way, E Avenue are important east-west cross town streets that are proposed to be extended to connect with Dow Road. It is desirable from an operations and safety standpoint that these roads be widened to 24 feet (2 lanes).

Harper Avenue, Fayetteville Road, Spartanburg Road, Ocean Boulevard, K Avenue and Assembly Avenue are all east-west cross streets that will enhance the travel flows from Dow Road to US 421. It is desirable from an operations and safety standpoint that these roads be widened to 24 feet (2 lanes).

Together these two groups of roads will offer tremendous travel relief facilitating the movement of traffic between US 421 and Dow Road. By having a series of east west minor thoroughfares, the complete burden of cross island travel does not fall directly on any one road. Just as the major developments are spaced intermittently along US 421, the travel accessing these developments will also be spread out.

Multi-Modal Considerations

As part of a thoroughfare plan study, modes of travel other than the automobile were also considered. For this area, bicycle travel is a very real choice. However, current conditions make bicycle travel very unsafe. A proposed bikeway being studied by Kure Beach will aid in encouraging bicycle travel on the island. In addition, as US 421 is improved, it is recommended that additional width be added to allow for the safe use of bicycles.

While a typical bus sytem may not an attractive solution to the summer travel on the island, a rubber tired trolley system would work very well. The basic concept would be to link the aquarium, Fort Fisher and Kure Beach together with the Northern Extension, the Boardwalk, Carolina Beach State Park and Federal Point Shopping Center with a rubber tired

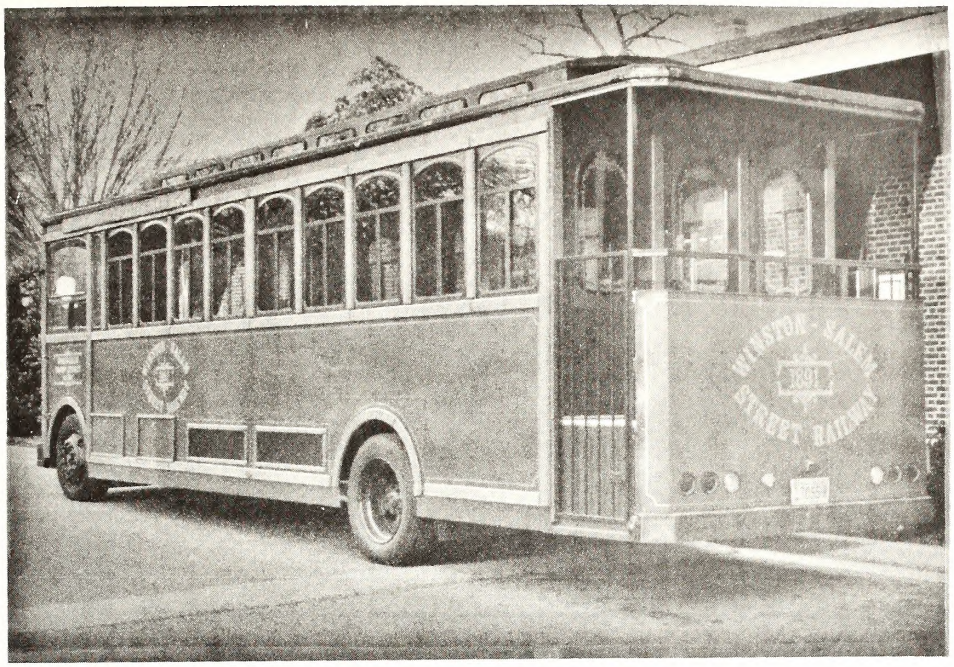


Figure 8

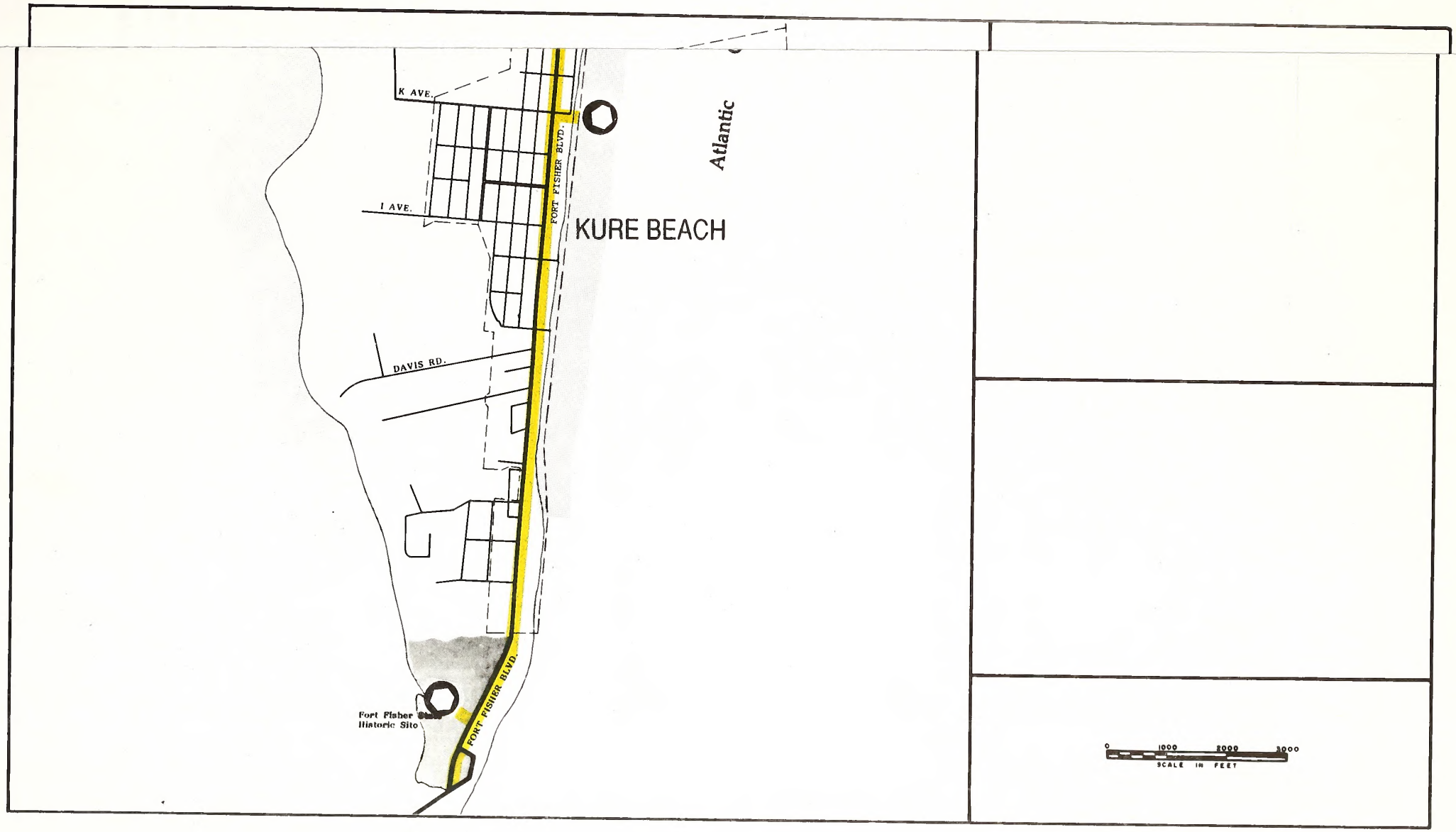
greatly reduce the number vehicle trips made on the island, and 2) it would make the major attractions more accesible to a greater number of people.

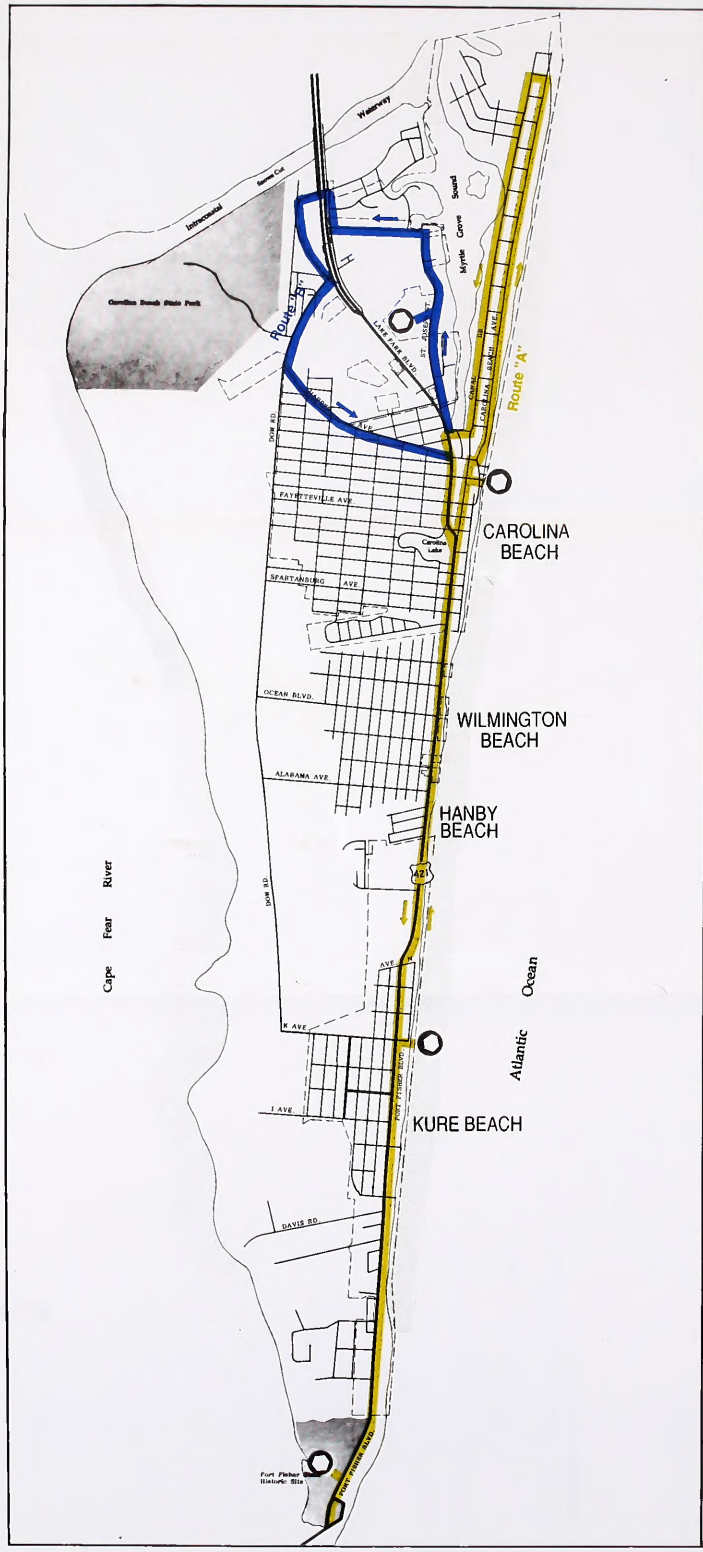
One example of a possible fixed route system is shown in figure 9. By operating two rubber tired trolleys, 30 minute headways can be obtained. This would result in having one trolley going north and one going south at all times. Greater Service can be obtained by alternatingthe routes on the Northern erd as shown.

The following is an example of what a system would cost:

2 handicapped equipeed trolleys	$300,000
Operating Costs	$ 400/day
Cost of Drivers	$ 375/day

It is possible that some federal funds could be available to help purchase the equipment. While operating funds are not available from the Federal Transit Administratrion, it is entirely possible that the system, operating only during the tourist season, could easily pay for itself. At the minimum fare of $0.10/trip, only 7,750 passengers/day would be required in order for the operating costs to be covered. Considering the population of the island swells to 30,000-35,000 people during the peak months, and most people would be within a quarter mile of a trolley, there should be sufficient demand for the system. In addition, since the system would be so beneficial to the retail and eating establishments of the island, a minimal tax could be levied to cover part of the costs, or a portion of the Counties room and meals tax could be used for operating expenses.


K AVE.
I AVE.
DAVIS RD.
FORT FISHER BLVD.
FORT FISHER BLVD.
KURE BEACH
Atlantic
Fort Fisher
Historic Site
0
1000
2000
3000
SCALE IN FEET



CAROLINA BEACH & KURE BEACH

NORTH CAROLINA

PREPARED BY THE

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

DIVISION OF HIGHWAYS-PLANNING AND ENVIRONMENTAL BRANCH

IN COORDINATION WITH

U.S. DEPARTMENT OF TRANSPORTATION

FEDERAL HIGHWAY ADMINISTRATION

MAY 1991

FIGURE 9

PROPOSED TROLLEY SYSTEM

LEGEND

- Proposed Route "A"
- Proposed Route "B"
- Proposed Major Trolley Stop

0 1000 2000 4000

SCALE IN FEET

establishments of the island, a minimal tax could be levied to cover part of the costs, or a portion of the Counties room and meals tax could be used for operating expenses.

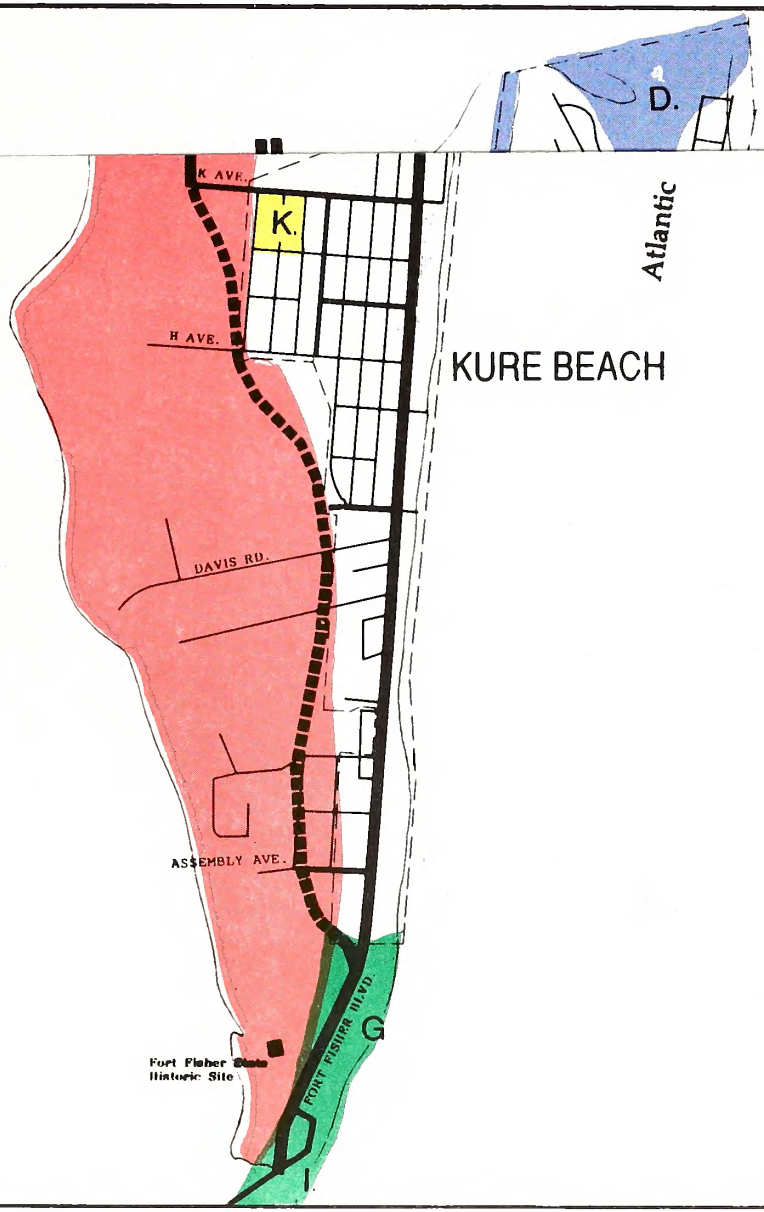
Need For, and Relationship Between the Proposed Improvements and the Environment

As with any major construction project there are bound to be conflicts between the environment and the activity. The environment is made of several different elements: neighborhoods, historic properties, natural environment (see Figure 10). In most instances, in order for a major project to get built, there must be compromises between these elements.

Typically the state will only consider building those roads that are identified on the thoroughfare plan as major thoroughfares. The extension of Dow Road is the only new major thoroughfare that is recommended to be built on the adopted plan. The estimated construction cost of the entire project (widening and new location) is $8,000,000 (not including right of way). The Department of Transportation utilizes a user's benefits program to help prioritize construction projects. It calculates the savings in accident costs, operating costs and time cost of building or improving a road. Based on the average daily traffic that would use the new facility, one could expect a user savings of $93.8 million over the 20 year life of the project (or a benefits/cost of almost 12 to 1).

The apparent social impacts resulting from widening Dow Road are not that significant. The majority of the project lies within government owned lands where no private development is allowed. However, private development has occurred on Dow Road from US 421 to Fayetteville Road. There are currently 6 homes, 1 church, and a fire station built adjacent to the existing ROW line on the east side. On the west side is a mini storage warehouse and the public utilities buildings of Carolina Beach. It is likely, that in order to diminish the effects of the widening on the existing homes and church, the additional ROW will be taken from the western side of Dow Road. It is imperative that if the rest of this land (now zoned I-1) is developed, that the Town of Carolina Beach preserve the future ROW for the widening of this road.

The southern portion of Dow Road ties back into US 421 just to the north of the Fort Fisher Historic Site. Fort Fisher is designated on the National Register of Historic Places and it is very improbable that we could ever extend the road across the Site. Tying the road back in at this point offers several distinct advantages. Firstly, it will offer a much needed buffer between the Historic Site and the private development to the north. Secondly, while the



F. Local Park

G. Fort Fisher

H. Buffer Zone

I. North Carolina Aquarium

J. Boardwalk

K. Local Park

ADOPTED BY:
TOWN OF CAROLINA BEACH JANUARY 14, 1992

TOWN OF KURE BEACH SEPTEMBER 17, 1991

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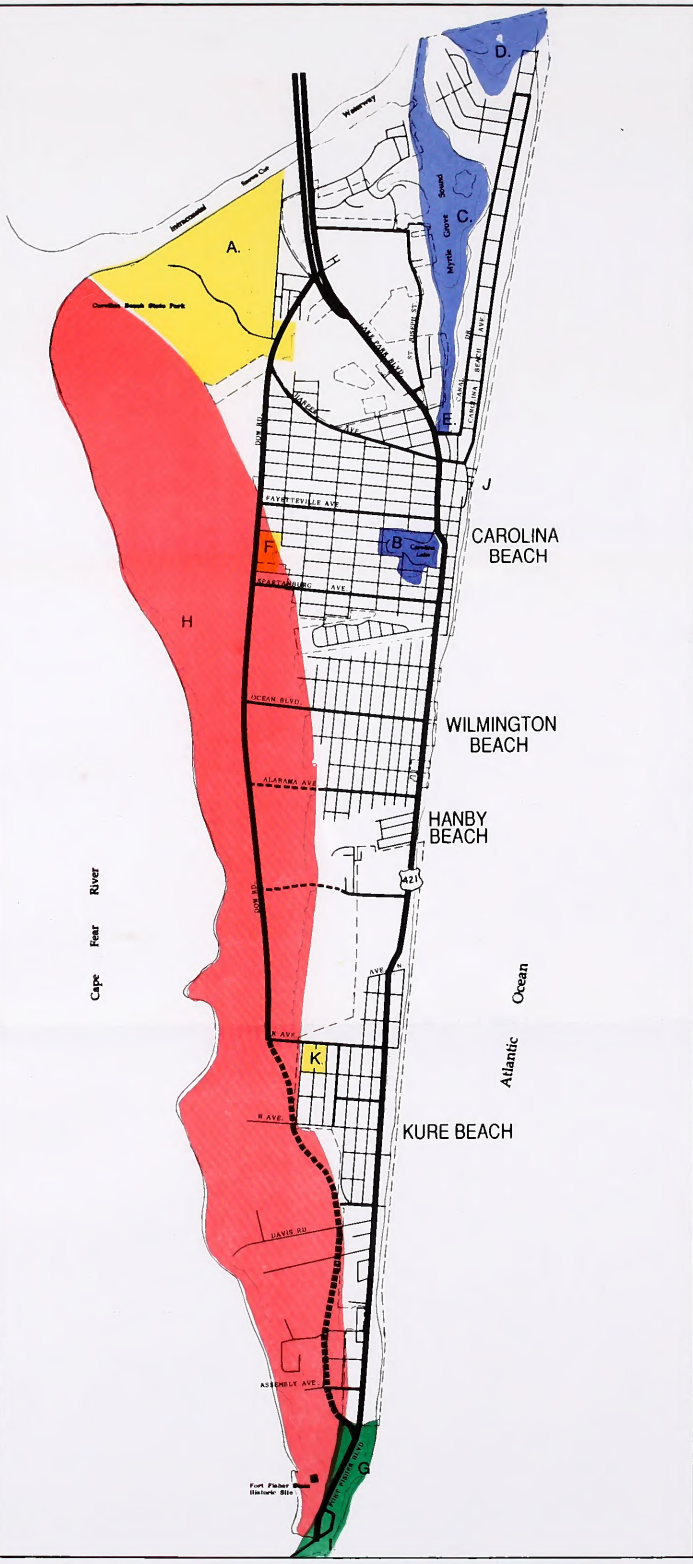

THOROUGHFARE PLAN

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FEDERAL HIGHWAY ADMINISTRATION

JUNE 10, 1991

LEGEND

	EXISTING	PROPOSED
MAJOR THOROUGHFARE		
MINOR THOROUGHFARE		

FIGURE 10
ENVIRONMENTAL CONCERNS

KEY

A. Carolina Beach State Park
B. Carolina Lake Park
C. Myrtle Grove Sound
D. Estmarine System
E. Marina
F. Local Park
G. Fort Fisher
H. Buffer Zone
I. North Carolina Aquarium
J. Boardwalk
K. Local Park

ADOPTED BY: TOWN OF CAROLINA BEACH JANUARY 14, 1992
TOWN OF KURE BEACH SEPTEMBER 17, 1991

RECOMMENDED FOR APPROVAL BY: NC DEPARTMENT OF TRANSPORTATION STATEWIDE PLANNING BRANCH MARCH 9, 1992

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SCALE IN FEET

existing US 421 north of this point is vulnerable to beach erosion and overflow, it is generally felt that US 421 below this point will be protected by whatever measures are taken to preserve the Fort. The proposed Extension has been designed to decrease the impact on the Historic Fort, while making it more accessible for those who wish to visit.

In addition to the Dow Road extension, the study also recommends that the two lane portions of US 421 be widened to three lanes. This is expected to greatly increase the internal traffic flow on the island. It will also improve accessibility to the existing land and reduce accidents. It must be pointed that while widening US 421 would offer significant benefits ($80 million over a 20 year period), it is not a suitable replacement to the Dow Road improvements and extension. As with Dow Road, it is very important that the Towns preserve the future right of way for the widening.

The user benefits program only takes into account the actual user costs associated with the automobile and its occupants. Without an adequate transportation system, the island's tourism industry could very well suffer. These potential loses are not accounted for in the benefit/cost ratio, but should be considered when the local officials are deciding whether to implement the thoroughfare plan.

VI. ADMINISTRATIVE CONTROLS AND IMPLEMENTATION TOOLS

State and Municipal Adoption of the Thoroughfare Plan

Chapter 136, Article 3A, Section 136-66.2 of the General Statutes of North Carolina provides that after development of a thoroughfare plan, the plan may be adopted by the governing body of the municipality and the Department of Transportation to serve as the basis for future street and highway improvements. The General Statutes also require that, as part of the plan, the governing body of the municipality and Department of Transportation shall reach agreement on responsibilities for existing and proposed streets and highways included in the plan. Facilities which are designated a State responsibility will be constructed and maintained by the Division of Highways. Facilities which are designated a municipal responsibility will be constructed and maintained by the municipality.

After mutual plan adoption, the Department of Transportation will initiate negotiations to determine which of the existing and proposed thoroughfares will be a Department responsibility and which will be a municipal responsibility. Chapter 136, Article 3A, Section 136-66.1 of the General Statutes provides guidance in the delineation of responsibilities. In summary, these statutes provide that the Department of Transportation shall be responsible for those facilities that serve volumes of through traffic and traffic from outside the area to major business, industrial, governmental, and institutional destinations located inside the municipality. The municipality is responsible for those facilities that serve primarily internal travel.

Unless implementation is an integral part of the transportation planning process, the effort and expense associated with developing a plan is lost. To neglect the implementation process is a three-fold loss: the loss of the capital expenditures used in developing a plan, the opportunity cost of the capital expenditures, and more importantly, the loss of the benefits that would accrue from an improved transportation system. Implementation is also important in another respect. When combined, the needs of each city far outweigh the resources available to build and maintain roads. Funds are limited and different communities must complete for the limited funds. An aggressive implementation strategy by local officials can greatly reduce the cost of funding a project and may have a positive impact on getting projects funded in the State's Transportation Improvement Program.

Administrative controls and implementation tools that can aid in the implementation process are generally available to municipalities through Federal and State Legislation. These controls and tools will be discussed in this chapter. They include: Subdivision Regulations, Zoning Ordinances, Official Corridor Maps, Urban Renewal, Capital Improvement Programs, and

Development Reviews. Generally, two issues play a major role in the implementation process - available finances and citizen involvement. Effective use of the controls and tools listed above are indicative of good planning, and minimize the effects of limited finances and negative citizen reaction to specific elements of a plan. It is through good planning that maximum use is made of every available dollar and that citizen involvement and approval of the transportation plan is obtained.

Available Controls and Tools

Subdivision Regulations

Subdivision regulations are locally adopted laws governing the process of converting raw land into building sites. On the planning side, subdivision regulations are important at two distinct levels. First, they enable the City to coordinate the otherwise unrelated plans of many individual developers. This process assures that provisions are made for land development elements such as roadway right-of-way, parks, school sites, water lines and sewer outfalls, and so forth. Second, they enable the City to control the internal design of each new subdivision so that its pattern of streets, lots, and other facilities will be safe, pleasant, and economical to maintain.

To be most effective, subdivision regulations and their administration must be closely coordinated with other local governmental policies and ordinances. Among the more important of these are the Comprehensive Growth Plan, Utilities Extension Master Plan, and Thoroughfare Plan.

In practice, subdivision regulations can be very beneficial. Its benefits include requiring portions of major streets to be constructed in accordance with the Thoroughfare Plan, or requiring subdividers to provide for the dedication and/or reservation of rights-of-way in advance of construction. These practices reduce the overall cost of the plan by having some costs borne by developers. Recommended definitions and design standards that should be included in subdivision ordinances are contained in Appendix B.

Zoning Ordinances

Zoning is probably the single most commonly used legal device available for implementing a community's land-use plan. To paraphrase the U.S. Department of Commerce 1924 Standard Zoning Enabling Act, on which most present-day legislation is based, zoning may be defined as the division of a municipality (or other governmental unit) into districts, and the regulation within the districts of:

1. the height and bulk of buildings and other structures,
2. the area of a lot that may be occupied and the size

of required open spaces,
3. the density of population, and
4. the use of buildings and land for trade, industry, residence, or other purposes.

The characteristic feature of the zoning ordinance that distinguishes it from most other regulations is that it differs from district to district, rather than being uniform throughout a city. Thus, a given area might be restricted to single-family residential development with minimum lot size requirements and setback provisions appropriate for development. In other areas, commercial or industrial development might be permitted, and regulations would be enacted to control such development. Building code provisions or sanitary regulations, on the other hand, normally apply to all buildings in a certain category regardless of where they may be situated within a city.

The zoning ordinance does not regulate the design of streets, utility installation, the reservation or dedication of parks, street rights-of-way, school sites, and related matters. These are controlled by subdivision regulations or possibly by use of an official map. The zoning ordinance should however, be carefully coordinated with these and other control devices.

Official Maps

The roadway corridor official map (or official map) is a document, adopted by the legislative body of the community, that pinpoints and preserves the location of proposed streets against encroachment. In effect, the official map serves notice on developers that the State or municipality intends to acquire certain specific property. The official map serves as a positive influence for sound development by reserving sites for public improvements in anticipation of actual need.

The NCDOT position is that it will limit the use of official maps to large scale, fully access controlled facilities planned for rapidly developing areas outside of municipal jurisdictions. For projects within municipal jurisdictions, official maps should be prepared and adopted by the local government. Municipalities may adopt official maps that extend beyond its extraterritorial jurisdiction with approval from the Board of County Commissioners.

It should be recognized that an official map places severe but temporary restrictions on private property rights. These restrictions are in the form of a prohibition, for up to three years, on the issuance of building permits or the approval of subdivisions on property lying within an official map alignment. The three year reservation period begins with the request for development approval. This authority should be used carefully and only in cases where less restrictive powers are found to be ineffective.

Requests for NCDOT to prepare and adopt an official map

should be directed to the manager of the Program, Policy and Budget Branch. For cities contemplating the adoption of an official map, there are two ways in which the city may proceed. The first is to consider the official map statute as a stand-alone authority and use it as the basis for local adoption of an official map. Alternatively, the second approach is to adopt a local ordinance modeled after the statute, but modified to fit local circumstances and clarify the statute. Regardless of the approach taken, several procedural steps will need to be considered, such establishing procedures for consideration of variance petitions.

Once the project has been selected and the alignment determined, maps must be prepared that are suitable for filing with the County Register of Deeds Office. The map should show the proposed alignment in sufficient detail to identify the functional design and the preliminary right-of-way boundaries. Since the purpose of the map is to show the effect on properties along the project path, the existing property boundaries should be identified. As an additional requirement, within one year of the adoption of an official map, work must begin on an environmental impact study or preliminary engineering.

It is important to recognize the risks inherent in the adoption of an official map prior to completing the environmental studies. Projects to be funded using any federal funds require the unbiased evaluation of alternate alignments. This means that other alternatives will be studied and compared to the protected alignment.[1]

The above information is only to serve as an introduction to official maps, and in no way provides the information necessary to begin development of an official map. The Program and Policy Branch of the North Carolina Department of Transportation is responsible for facilitating the adoption of Official Street Maps. Cities considering Official Street Map projects should contact this Branch for their "Guidelines for Municipalities Considering Adoption of Roadway Corridor Official Maps" at:

Programming, Policy and Budget Branch
NC Department of Transportation
P.O. Box 25201
Raleigh, North Carolina 27611

Urban Renewal

Urban renewal plays a minor role in the transportation planning implementation process in terms of scope and general

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[1] "Guidelines for Municipalities Considering Adoption of Roadway Corridor Official Maps," prepared by NCDOT Program, Policy and

influence. However, under the right circumstances, renewal programs can make significant contributions. Provisions of the New Housing Act of 1974 (as amended) call for the conservation of good areas, rehabilitation of declining areas, and clearance of slum areas. In the course of renewal, it is important to coordinate with the Thoroughfare Plan to see if additional set-back or dedication of right-of-way is needed.

Continued use of the urban renewal programs to improve the transportation system is encouraged. Changes that can be made under this program are generally not controversial or disruptive given the trauma of the clearance of a significant area.

Capital Improvement Programs

Capital programs are simply the coordination of planning and money. The capital improvements program, with respect to transportation, is a long range plan for the spending of money on street improvements, acquisition of rights-of-way and other improvements within the bounds of projected revenues. Municipal funds should be available for construction of street improvements which are a municipal responsibility, right-of-way cost sharing on facilities designated a Division of Highways responsibility and advance purchase of right-of-way where such action is warranted.

Historically, cities and towns have depended, to a great degree, on Federal or State funding to solve their transportation problems. Chapter 136-Article 3A of the Road and Highway Laws of North Carolina clearly outlines the responsibilities and obligations of the various governmental bodies regarding highway improvements. North Carolina Highway Bill 1211, passed in 1988, limits the role of municipalities in right-of-way cost sharing for projects once they are programed in the NCDOT Transportation Improvement Program. Set-back regulations, right-of-way dedications and reservations play a major role in the ultimate cost of many facilities. Only in special cases will the municipality be able to enjoy the benefits of highway improvements without some form of investment.

Development Reviews

Driveway access to a State-maintained street or highway is reviewed by the District Engineer's office and by the Traffic Engineering Branch of the North Carolina Department of Transportation prior to access being allowed. Any development expected to generate large volumes of traffic (ie. shopping centers, fast food restaurants, large industries, etc.) may be comprehensively studied by staff from the Traffic Engineering, Statewide Planning, and Roadway Design Branches of NCDOT. If done at an early stage, it is often possible to significantly improve the development's accessibility at minimal expense. Since the

municipality is the first point of contact for developers, it is important that the municipality advise them of this review requirement and cooperate in the review process.

Other Funding Sources

The above mentioned tools are available to the city to bring about the implementation of the thoroughfare plan. Actual funding of the major thoroughfare improvements may be accomplished in a variety of ways. Common examples are listed below:

1. User impact fees can be used to fund transportation projects. These fees, called "facility fees" in the legislation, are to be based upon "reasonable and uniform considerations of capital costs to be incurred by the town as a result of new construction. The facility fee must bear a direct relationship to additional or expanded public capital costs of the community service facilities to be rendered for the inhabitants, occupants of the new construction, or those associated with the development process."

2. Enact a bond issue to fund street improvements.

3. Continue to work with NCDOT to have local projects included in the Transportation Improvement Program (TIP).

4. Consider the possibility of specific projects qualifying for federal demonstration project funds.

5. Adopt a collector street plan that would assess buyer or property owners for street improvements.

6. Charge a special assessment for utilities. For example, water and sewer bills could be increased to cover the cost of street improvements.

APPENDICES

APPENDIX A

DESIGN REQUIREMENTS

Design requirements for thoroughfares vary according to the desired capacity and levels of service to be provided. Universal standards in the design of thoroughfares are not practical. Each street section must be individually analyzed and its design requirements determined on the basis of amount and type of projected traffic, existing capacity, desired level of service, and available right-of-way.

Recommended typical cross sections were derived on the basis of projected traffic, existing capacities, desirable levels of service and available right-of-way. The recommended typical cross sections for the thoroughfares are given in Table A 1 along with other pertinent information. These proposed cross sections are only recommendations of the type and size of facility required to accommodate future travel growth. Once the project is funded, further study will be required to determine the exact type of roadway that will be built.

Cross section "A" is typical for controlled access freeways. The 46 foot grassed median is the minimum desirable median width, but there could be some variation from this depending upon design considerations. Slopes of 8:1 into 3 foot drainage ditches are desirable for traffic safety. Right-of-way requirements would typically vary upward from 250 feet depending upon cut and fill requirements.

Cross section "B" is typical for four lane divided highways in rural areas which may have only partial, or no control of access. The minimum median width for this cross section is 30 feet, but a wider median is desirable. Design requirements for slopes and drainage would be similar to cross section "A", but there may be some variation from this depending upon right-of-way constraints.

Cross section "C", seven lane urban, and cross section "D", five lane urban, are typical for major thoroughfares where frequent left turns are anticipated as a result of abutting development or frequent street intersections.

Cross sections "E" and "F" are used on major thoroughfares where left turns and intersecting streets are not as frequent. Left turns would be restricted to a few selected intersections.

Cross section "G" is recommended for urban boulevards or parkways to enhance the urban environment and to improve the compatibility of major thoroughfares with residential areas. A minimum median width of 24 feet is recommended with 30 feet being desirable.

Typical cross section "H" is recommended for major thoroughfares where projected travel indicates a need for four travel lanes but traffic is not excessively high, left turning movements are light, and right-of-way is restricted. An additional left turn lane would

probably be required at major intersections.

Thoroughfares which are proposed to function as one-way traffic carriers would typically require cross section "I". Cross section "J" and "K" are usually recommended for minor thoroughfares since these facilities usually serve both land service and traffic service functions. Cross section "J" would be used on those minor thoroughfares where parking on both sides is needed as a result of more intense development.

Cross section "L" is used in rural areas or for staged construction of a wider multilane cross section. On some thoroughfares projected traffic volumes may indicate that two travel lanes will adequately serve travel for a considerable period of time.

All of the curb and gutter urban cross sections illustrate the sidewalk adjacent to the curb with a buffer or utility strip between the sidewalk and the minimum right-of-way line. This permits adequate setback for utility poles. If it is desired to move the sidewalk further away from the street to provide additional separation for pedestrians or for aesthetic reasons, additional right-of-way must be provided to insure adequate setback for utility poles.

Right-of-ways shown for the typical cross sections are the minimum right-of-ways required to contain the street, sidewalks, utilities, and drainage facilities. Cut and fill requirements may require either additional right-of-way or construction easements. Obtaining construction easements is becoming the more common practice for urban thoroughfare construction.

If there is sufficient bicycle travel along the thoroughfare to justify a bicycle lane or bikeway, additional right-of-way may be required to contain the bicycle facilities. The North Carolina Bicycle Facility and Program Handbook[1] should be consulted for design standards for bicycle facilities.

On all existing and proposed major thoroughfares delineated on the thoroughfare plan, it is recommended that adequate right-of-way be protected or acquired for the ultimate cross sections. The ultimate desirable cross sections for thoroughfares are also listed in Table A-1. Recommendations for "ultimate" cross sections are provided for (1) thoroughfares which may require widening after the current planning period; (2) for thoroughfares which are borderline adequate and accelerated traffic growth could render them deficient; and (3) for thoroughfares where an urban curb and gutter cross section may be locally desirable because of urban development or redevelopment.

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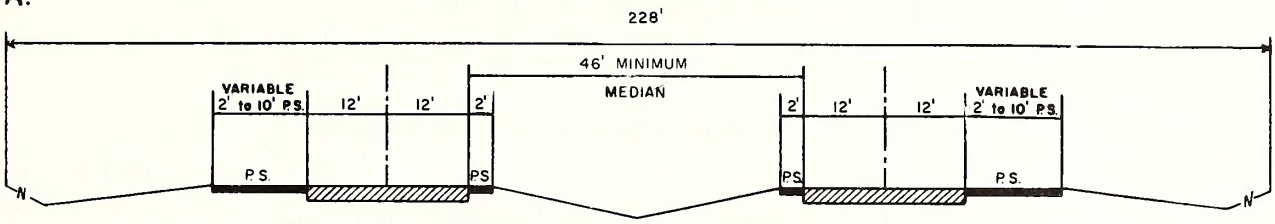
[1] Guide for the Development of New Bicycle Facilities, 1981, American Association of State Highway and Transportation Officials.

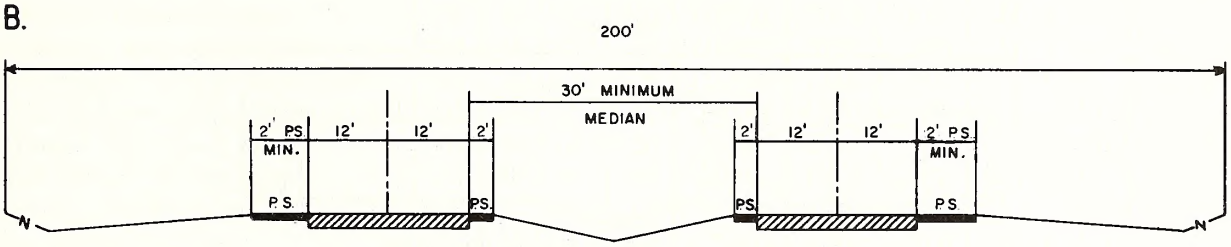
TYPICAL THOROUGHFARE CROSS SECTIONS

A.



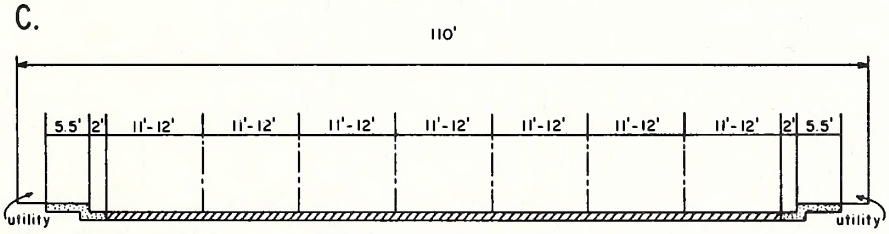
FOUR LANES DIVIDED WITH MEDIAN - FREEWAY

B.



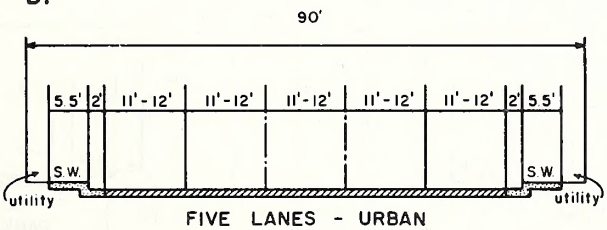
FOUR LANES DIVIDED WITH MEDIAN - RURAL

C.



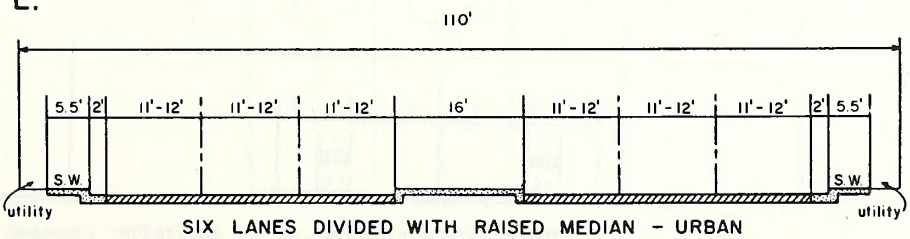
SEVEN LANES - URBAN

D.



FIVE LANES - URBAN

E.

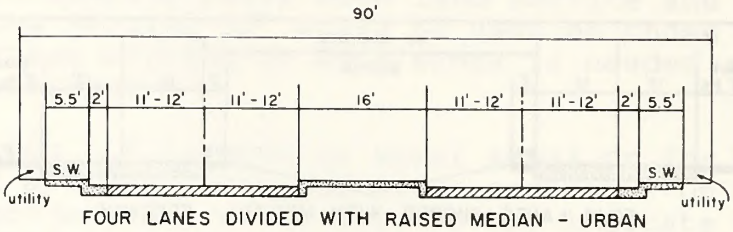


SIX LANES DIVIDED WITH RAISED MEDIAN - URBAN

FIGURE A-1

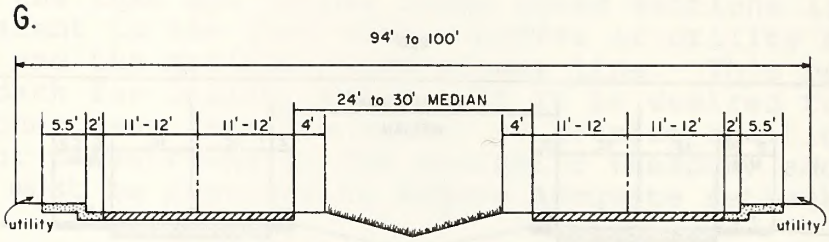
TYPICAL THOROUGHFARE CROSS SECTIONS
(CONTINUED)

F.



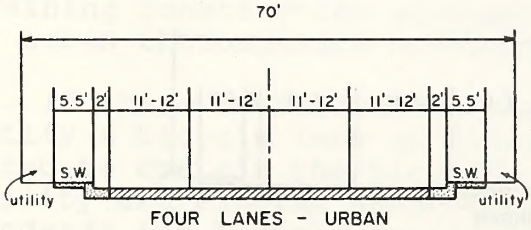
FOUR LANES DIVIDED WITH RAISED MEDIAN - URBAN

G.



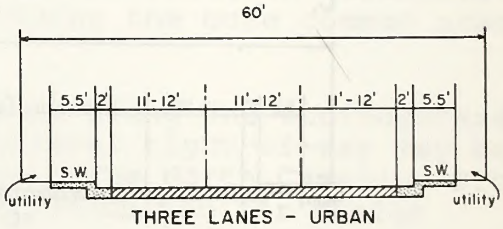
FOUR LANES DIVIDED - URBAN BOULEVARD
GRASS MEDIAN

H.



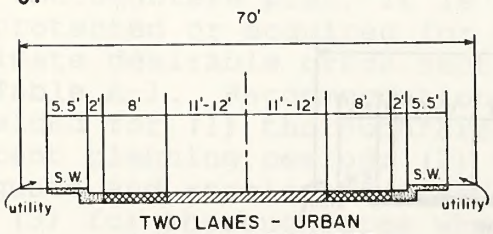
FOUR LANES - URBAN

I.



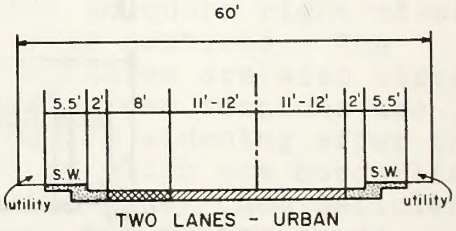
THREE LANES - URBAN

J.



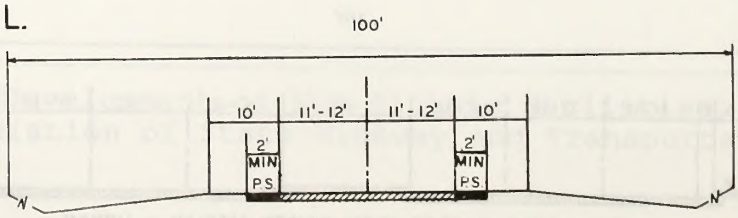
TWO LANES - URBAN
PARKING ON EACH SIDE

K.



TWO LANES - URBAN
PARKING ON ONE SIDE

L.



TWO LANES - RURAL

Table A-1

Thorughfare Plan Street Tabulations and Recommendations

Street	EXISTING CROSS SECTION				PRACTICAL CAPACITY	TRAFFIC		RECOMMENEDED CROSS SECTION	
	DIST (MI)	RDWY (FT)	NO OF LANES	ROW (FT)	CURRENT (FUTURE)	1991 COUNT[1]	2015 COUNT	RDWY (ULT)	ROW (ULT)
US 421									
SR 1517 - Dow Road	.49	22	2	60	10000	4500	9900	L	ADQ
Dow Road - Assembly Avenue	.22	22	2	60	(14700)	4500	5000	I	ADQ
Assembly Avenue - E Avenue	.81	22	2	50	(14700)	6000	6200	I	60
E Avenue - K Avenue	.69	42	2	50	(14700)	7000	7800	I	60
K Avenue - Club Drive	.68	42	2	50	(14700)	7500	8000	I	60
Club Drive - Alabama Avenue	.44	22	2	100	(14700)	7500	8000	I	ADQ
Alabama Avenue - Ocean Boulevard	.33	22	2	100	(14700)	7500	8000	I	ADQ
Ocean Boulevard - Spartanburg Avenue	.52	44	2	50	(14700)	10000	9600	I	60
Spartanburg Avenue - Fayetteville Avenue	.38	36	2	50	(14700)	10000	9600	I	60
Fayetteville Avenue - Harper Avenue	.25	58	4	50	26500	12600	9600	ADQ	ADQ
Harper Avenue - Carl Winner Avenue	.11	84	4	50	26500	13000	11000	ADQ	ADQ
Carl Winner Avenue - Winner Avenue	.23	48	4	60	26500	13000	11000	ADQ	ADQ
Winner Avenue - Dow Road	.64	48	4	60	26500	12500	11500	ADQ	ADQ
Dow Road - Snow's Cut Bridge	.57	48	4	200	33500	11500	22000	ADQ	ADQ
DOW ROAD									
Fort Fisher Boulevard - K Avenue[2]	1.84	-	-	-	(16400)	-	9600	I	70
K Avenue - Lake Park Boulevard	3.45	22	2	60	(33500)	2800	15300	G	100
CAROLINA BEACH AVENUE									
Harper Avenue - Sea Oats Lane	1.62	22	1	50	6500	3000	4500	ADQ	ADQ
CANAL DRIVE									
Carl Winner Avenue - Sea Oats Lane	1.36	22	2	50	(15000)	7600	8900	(I)	(60)
CARL WINNER AVENUE									
Lake Park Boulevard - Canal Drive	.11	30	2	50	(15000)	7200	12300	(I)	(60)
St JOSEPH STREET									
Lake Park Boulevard - Lewis Drive	.69	22	2	60	10000	1800	4500	K	ADQ
LEWIS DRIVE									
St Joseph Street - Access Road	.40	22	2	60	10000	1000	3200	K	ADQ
HARPER AVENUE									
Dow Road - Lake Park Boulevard	.89	24	2	60	10000	1000	16000	I	ADQ
Lake Park Boulevard - Carolina Beach Avenue	.11	24	2	60	10000	1200	12200	I	ADQ
FAYETTEVILLE AVENUE									
Dow Road - US 421	.78	24	2	50	8000	1000	3600	K	60
SPARTANBURG AVENUE									
Dow Road - US 421	.81	18	2	50	(10000)	1000	4500	K	60

[1] Average Daily Travel - Seasonal variations may increase these volumes by 25 to 50 percent.

[2] Proposed Road

Table A-1

Thorughfare Plan Street Tabulations and Recommendations

Street	EXISTING CROSS SECTION				PRACTICAL CAPACITY	TRAFFIC		RECOMMENEDED CROSS SECTION	
	DIST (MI)	RDWY (FT)	NO OF LANES	ROW (FT)	CURRENT (FUTURE)	1989 COUNT	2010 COUNT	RDWY (ULT)	ROW (ULT)
OCEAN BOULEVARD									
Dow Road - US 421	.79	18	2	50	(10000)	1000	4000	K	60
ALABAMA AVENUE									
*Dow Road - Existing[2]	.13				(10000)	-	4000	K	60
Existing - US 421	.60	18	2	50	(10000)	800	4000	K	60
CLUB DRIVE									
*Dow Road - Existing[2]	.14				(10000)	-	3800	K	60
Existing - US 421	.59	18	2	50	(10000)	800	3800	K	60
K AVENUE									
Dow Road - US 421	.51	24	2	60	(10000)	1150	8000	I	60
E AVENUE									
Dow Road - US 421	.17	18	2	50	(10000)	200	3200	K	60
ASSEMBLY AVENUE									
Dow Road - US 421	.14	18	2	50	(10000)	225	1500	K	60

[1] Average Daily Travel - Seasonal variations may increase these volumes by 25 to 50 percent.

[2] Proposed Road

APPENDIX B

RECOMMENDED DEFINITIONS AND DESIGN STANDARDS FOR SUBDIVISION ORDINANCES

Definitions

I. Thoroughfare System

A. Rural Street System

1. Principal Arterial - A rural road in a highway system serving corridor movements having trip length and travel density characteristics indicative of substantial state-wide or interstate travel and existing solely to serve traffic. This network would consist of interstate routes and other routes designated as principal arterials.

2. Minor Arterial - A rural road in a highway system joining cities and larger towns. It provides for intrastate and intercounty service at relatively high overall travel speeds with minimum interference to through movement.

3. Major Collector - A road which serves major intracounty travel corridors and traffic generators. It provides access to the Principal and Minor Arterial system.

4. Minor Collector - A road which provides service to small local communities and links the locally important traffic generators with their rural extremes.

5. Local Road - A local road that serves primarily to provide access to adjacent land. It is normally used for travel over relatively short distances.

B. Urban Street System

1. Major Thoroughfares - Major thoroughfares consist of interstate, other freeway, expressway, or parkway links, and major streets that provide for the expeditious movement of high volumes of traffic within and through urban areas.

2. Minor Thoroughfares - Minor thoroughfares are important streets in the city system. They perform the function of collecting traffic from the local access streets and carrying it to the major thoroughfare system. Minor thoroughfares may be used to supplement the major thoroughfare system by facilitating a minor through traffic movement and may also serve abutting property to a limited extent.

3. Local Streets - A local street is any link not on a higher-order urban system and serves primarily to provide

direct access to abutting land and access to higher systems.

C. Rural or Urban Streets

1. Freeway, expressway, or parkway - Divided multi-lane roadways designed to carry large volumes of traffic at relatively high speeds. A freeway is a divided highway providing for continuous flow of vehicles with no direct access to abutting property or streets and with access to selected crossroads provided via connecting ramps. An expressway is a divided highway with full or partial control of access and generally with grade separations at major intersections. A parkway is a highway for noncommercial traffic, with full or partial control of access, and usually located within a park or a ribbon of park-like development.

2. Residential Collector Street - A local access street which serves as a connector street between local residential streets and the thoroughfare system. Residential collector streets typically collect traffic from 100 to 400 dwelling units.

3. Local Residential Street - Cul-de-sacs, loop streets less than 2,500 feet in length, or streets less than one mile in length that do not connect thoroughfares, or serve major traffic generators, and do not collect traffic from more than 100 dwelling units.

4. Cul-de-sac - A short street having but one end open to traffic and the other end being permanently terminated and a vehicular turn around provided.

5. Frontage Road - A local street or road that is parallel to a full or partial access controlled facility and functions to provide access to adjacent land.

6. Alley - A strip of land, owned publicly or privately, set aside primarily for vehicular service access to the back side of properties otherwise abutting on a street.

II. Property

A. Building Setback Line - A line parallel to the street in front of which no structure shall be erected.

B. Easement - A grant by the property owner for use by the public, a corporation, or person(s), of a strip of land for a specific purpose.

C. Lot - A portion of a subdivision, or any other parcel of land, intended as a unit for transfer of ownership or for development or both. The word "lot" includes the words

"plat" and "parcel".

1. Corner Lot - A lot abutting upon two streets at their intersection.

2. Double-Frontage Lot - A continuous (through) lot which is accessible from both of the parallel streets upon which it fronts.

3. Reverse-Frontage Lot - A continuous (through) lot which is accessible from only one of the parallel streets upon which it fronts.

III. Subdivision

A. Subdivider - Any person, firm, corporation or official agent thereof, who subdivides or develops any land deemed to be a subdivision.

B. Subdivision - All divisions of a tract or parcel of land into two or more lots, building sites, or other divisions for the purpose, whether immediate or future, for sale or building development, and all divisions of land involving the dedication of a new street or a change in existing streets; provided, however, that the following shall not be included within this definition nor subject to these regulations: (1) the combination or re-combination of portions of previously platted lots where the total number of lots is not increased and the resultant lots are equal to or exceed the standards contained herein; (2) the division of land into parcels greater than five acres where no street right-of-way dedication is involved; (3) the public acquisition by purchase of strips of land for the widening or opening of streets; (4) the division of a tract in single ownership whose entire area is no greater than two acres into not more than three lots, where no street right-of-way dedication is involved and where the resultant lots are equal to or exceed the standards contained herein.

C. Dedication - A gift, by the owner, of his property to another party without any consideration being given for the transfer. Since a transfer of property is involved, the dedication is made by written instrument and is completed with an acceptance.

D. Reservation - A reservation of land does not involve any transfer of property rights. It simply constitutes an obligation to keep property free from development for a stated period of time.

Design Standards

The design of all streets and roads within an Urban Area shall be in accordance with the accepted policies of the North Carolina Department of Transportation, Division of Highways, as taken or modified from the American Association of State Highway and Transportation Officials (AASHTO) manuals[1].

The provision of street rights-of-way shall conform and meet the requirements of the Thoroughfare Plan for the Urban Area as adopted by the local bodies and the North Carolina Department of Transportation.

The proposed street layout shall be coordinated with the existing street system of the surrounding area. Normally the proposed streets should be the extension of existing streets if possible.

The urban planning area shall consist of that area within the urban planning boundary as depicted on the mutually adopted Thoroughfare Plan. The rural planning area shall be that area outside the urban planning boundary.

Right-of-Way

Right-of-way widths shall not be less than those shown in table B-1 and shall apply except in those cases where right-of-way requirements have been specifically set out in the Thoroughfare Plan.

The subdivider will only be required to dedicate a maximum of 100 feet of right-of-way. In cases where over 100 feet of right-of-way is desired, the subdivider will be required only to reserve the amount in excess of 100 feet. In all cases in which right-of-way is sought for an access controlled facility, the subdivider will only be required to make a reservation.

A partial width right-of-way, not less than sixty (60) feet in width, may be dedicated when adjoining undeveloped property that is owned or controlled by the subdivider; provided that the width of a partial dedication be such as to permit the installation of such facilities as may be necessary to serve abutting lots. When the said adjoining property is subdivided, the remainder of the full required right-of-way shall be dedicated.

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1. The design standards listed herein are only to be used as a guide. All designs should comply with such guides as A Policy on Geometric Design of Highways and Streets, 1984 (Green Book), AASHTO, Washington, D.C.

Street Widths

Street widths for street and road classifications other than local shall be as required by the Thoroughfare Plan. Width of local roads and streets shall be as follows:

1. Local Residential
   Curb and gutter section - 26 feet, to face of curb

   Shoulder section - 20 feet to edge of pavement, 4 foot shoulders

2. Residential Collector
   Curb and gutter section - 34 feet, face to face of curb

   Shoulder section - 20 feet to edge of pavement, 6 foot shoulders

Table B-1 Right-of-Way Widths

Type	Minimum Right-of-Way (ft)
Rural	
a. Principal Arterial	
Freeways	350
Other	200
b. Minor Arterial	100
c. Major Collector	100
d. Minor Collector	100
e. Local Road	60[1]
Urban	
a. Major Thoroughfare Other than Freeway and Expressway	90
b. Minor Thoroughfare	70
c. Local Street	60[1]
d. Cul-de-sac	Variable[2]

[1] The desirable minimum right-of-way (ROW) is 60 feet. If curb and gutter is provided, 50 feet is adequate on local residential streets.

[2] The ROW dimension will depend on the radius used for vehicular turn-around. Distance from edge of pavement of turn-around to ROW should not be less than the distance from the edge of pavement to the ROW on the street approaching the turn-around.

Geometric Characteristics

The standards outlined below shall apply to all subdivision streets proposed for addition to the State Highway System or Municipal Street System. In cases where a subdivision is sought adjacent to a proposed thoroughfare corridor, the requirements of

dedication and reservation discussed under Right-of-way shall apply.

Maximum grades should conform to those shown in table B-2. Minimum grades should not be less than 0.5%. Grades for 100 feet from each way of an intersection should not exceed 5%.

The **design speeds** for a roadway should be a minimum of 5 mph greater than the posted speed limit. The design speeds for subdivision type streets are shown in table B-3.

In the interest of public safety, no less than the minimum sight distance applicable shall be provided in every instance. Vertical curves that connect each change in grade shall be provided and

Table B-2 Maximum Grades

Design Speed	Terrain		
	Level	Rolling	Mountainous
60	3	4	6
50	4	5	7
40	5	6	8
30	-	9	10
20	-	-	12

Table B-3 Design Speeds

	Desirable	Minimum		
Rural		Level	Rolling	Mountain
Minor Collector Roads	60	50	40	30
Local Roads including Residential Collectors and Local Residential	50	50	40	30
Urban				
Major Thoroughfares other than Freeway or Expressway	60	50	50	50
Minor Thoroughfares	60	50	40	40
Local Streets	40	40	30	20

calculated using the parameters shown in table B-4. (General practice calls for vertical curves to be multiples of 50 feet. Calculated lengths shall be rounded up in each case).

Table B-5 shows the maximum degree of curve and related maximum superelevation for design speeds. The maximum rate of roadway superelevation (e) for rural roads with no curb and gutter

is 0.08. The maximum rate of superelevation for urban streets with curb and gutter is 0.06 with 0.04 desirable.

Intersections

Streets shall be laid out so as to intersect as nearly as possible to right angles, and no street should intersect any other at an angle of less than sixty degrees.

Property lines at intersections should be set so that the distance from the edge of pavement, of the street turnout, to the property line will be at least as great as the distance from the edge of pavement to the property line along the intersecting streets. This property line can be established as a radius or as a sight

Table B-4 Sight Distance

	Design Speed (mph)				
	20	30	40	50	60
Stopping Sight Distance					
Min. Distance, Ft.	150	200	275	350	475
Desirable Distance Ft.	150	200	300	450	650
Min. K* Value For:					
Minimum Crest Curve	16	28	55	85	160
Des. Crest Curve	16	28	65	145	300
Minimum Sag Curve	24	35	55	75	105
Des. Sag Curve	24	35	60	100	155
Passing Sight Distance - Minimum Passing Distance Feet (2 lane)	800	1100	1500	1800	2100
Minimum K[1] Value for Crest Vertical Curve		365	686	985	1340

1 K is a coefficient by which the algebraic difference in grade may be multiplied to determine the length in feet of the vertical curve which will provide minimum sight distance.

triangle. Greater offsets from the edge of pavement to the property lines will be required, if necessary, to provide sight distance for the stopped vehicle on the side street.

Off-set intersections are to be avoided unless exception is granted by the Division of Highways for intersections involving the State Highway System, or the Planning Board for intersections involving only the municipal street system. Intersections which cannot be aligned should be separated by a minimum length of 200 feet between surveyed centerlines.

Table B-5 Superelevation Table

Design Speed MPH	Max. e[1]	Minimum Radius Feet	Maximum Degree of Curve Degrees
20	.04	125	45.0
30	.04	300	19.0
40	.04	560	10.0
50	.04	925	6.0
60	.04	1410	4.0
20	.06	115	50.0
30	.06	275	21.0
40	.06	510	11.5
50	.06	830	7.0
60	.06	1260	4.5
20	.08	110	53.5
30	.08	250	23.0
40	.08	460	12.5
50	.08	760	7.5
60	.08	1140	5.0

[1] e = rate of roadway superelevation, foot per foot

Cul-de-sacs

Cul-de-sacs, unless exception is granted by the local planning board, shall not be more than five hundred feed in length. The distance from the edge of pavement on the vehicular turn-around to the right-of-way line should not be less than the distance from the edge of pavement to right-of-way line on the street approaching the turn-around. Cul-de-sacs should not be used to avoid connection with an existing street or to avoid the extension of an important street.

Alleys

Alleys should be required to serve lots used for commercial and industrial purposes except that this requirement may be waived where other definite and assured provision is made for service access. Alleys shall not be provided in residential subdivisions unless necessitated by unusual circumstances. The width of an alley shall be at least twenty feet. Dead-end alleys shall be avoided where possible, but if unavoidable, shall be provided with adequate turn-around facilities at the dead-end as may be approved by the Planning Board.

Permits For Connection To State Roads

An approved permit is required for connection to any existing

state system road. This permit is required prior to any construction on the street or road. The application is available at the office of the nearest District Engineer of the Division of Highways.

Offsets To Utility Poles

Poles for overhead utilities should be located clear of roadway shoulders, preferably a minimum of thirty feet from the edge of pavement. On streets with curb and gutter, utility poles should be set back a minimum distance of six feet from the face of curb.

Wheel Chair Ramps

In accordance with Chapter 136, Article 2A, ss136-44.14, all street curbs in North Carolina being constructed or reconstructed for maintenance purposes, traffic operations, repairs, correction of utilities, or altered for any reason after September 1, 1973, shall provide wheelchair ramps for the physically handicapped at all intersections where both curb and gutter and sidewalks are provided and at other major points of pedestrian flow. Wheelchair ramps and depressed curbs shall be constructed in accordance with details contained in the Department of Transportation, Division of Highways, Publication entitled, "Guidelines, Curb Cuts and Ramps for Handicapped Persons".

Horizontal Width on Bridge Decks

The clear roadway widths for new and reconstructed bridges serving 2 lane, 2 way traffic should be as follows:

Shoulder Section Approach	
Under 800 ADT During Design Year	Minimum 28 feet width face to face of parapets of rails or pavement width plus 10 feet, whichever is greater.
800-2000 ADT During Design Year	Minimum 34 feet width face to face of parapets or tails or pavement width plus 12 feet, whichever is greater.
Over 2000 ADT During Design Year	Minimum 40 feet, Desirable 44 feet width face to face of parapets or rails
Curbs and Gutter Approach	
Under 800 ADT During Design Year	Minimum 24 feet face to face of curbs.
Over 800 ADT During Design Year	Width of approach pavement measured face to face of curbs.

Where curb and gutter sections are used on roadway approaches, curbs on bridges shall match the curbs on approaches in height, in width of face to face of curbs, and in crown drop. The distance from face of curb to face of parapet or rail shall be 1'6" minimum, or greater if sidewalks are required.

The clear roadway widths for new and reconstructed bridges having four or more lanes undivided two-way traffic should be as follows:

Shoulder Section Approach
Width of approach pavement plus width of usable shoulders on the approach left and right. Minimum 8', Desirable 10'

Curb and Gutter Approach Width of approach pavement measured face to face of curbs.